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Application of N-15 Technique for Quantification of N-Fertilizer and N-Soil Uptake in Difference Maize Varieties

Penggunaan Teknik N-15 Untuk Kuantifikasi N-Pupuk dan N-Tanah pada Varietas Jagung Berbeda

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ABSTRACT

Application of N-15 Technique for Quantification of N-Fertilizer and N-Soil Uptake in Difference Maize Varieties. A pot study has been carried out, where the treatments were N-fertilizers (N-F) : F0 = without N-fertilizer (F), F1 = 100% anorganic N-F/urea, F2 = 100% organic N-F, and 50% anorganic + 50% organic N-F and three maize varieties namely, var. Anoman (A), var. Lamuru (L) and var. Sukmaraga (S). An Anova was implemented to observe any difference among the treatments and their interaction (N x F) for each parameter. The parameters applied were, percentage (%) of N-F, N-soil (N-S) and N- total (N-to) the N-F, N-S, N-to uptake (mg N), and dry weight (g S for all three plant parts (stem, leaves, panicles) and the whole plant (stem + leaves + panicles). Data showed that for the percentage (%), total : N uptake, dry weight, the highest values was for F1 compared to F0, F1, F2.. Whenever differents were found in treatment and interaction (VxF) by the parameters, it shown by the ANOVA that this was mainly due to the F treatment. The data also show that N-S uptake was much higher than the N-F uptake. It was found that although urea/anorganic fertilizer (F1) was found to give the highest values for nearly all the parameters, it used by plant expressed in percentage (%) was quite low, especially shown for the whole plant.

Key words : Maize varieties, quantification offertilizer, N-15 technique

ABSTRAK

Penggunaan Teknik N-15 Untuk Kuantifikasi N-Pupuk dan N-Tanah pada Varietas Jagung Berbeda. Telah dilaksanakan penelitian dengan melibatkan perlakuan pupuk - N; F0 : tanpa pupuk – N, F1 : 100 % pupuk – N anorganik/urea, F2 : 100 % pupuk – N organik, F3 : 50 % pupuk – N organik + 50 % pupuk – N anorganik, serta tiga varietas jagung : var. Anoman (A), var. Lamuru (L), var. Sukmaraga (S). Anova digunakan untuk menyatakan bila ada perbedaan antara perlakuan dan interaksinya (V x F). Parameter yang diamati adalah persentase (%) N – F, N – tanah (N - S) dan N – total (N – to) serta penyerapan, N - F, N – S dan N – to (mg N) serta berat kering (g) untuk tiga bagian tanaman : batang, daun, malai dan seluruh tanaman (batang + daun + malai). Data dalam studi ini menunjukkan bahwa untuk semua parameter F1 memperlihatkan nilai tertinggi di atas F0, F2, F3. Bila ditemukan perbedaan antara perlakuan dan interaksi (V x F) pada parameter, maka ANOVA menunjukkan bahwa hal tersebut disebabkan karena perlakuan F. Data juga menunjukkan bahwa penyerapan N-S adalah jauh lebih tinggi daripada N-F. Walaupun perlakuan F1 menunjukkan nilai tertinggi di atas perlakuan F lainnya, namun ditemukan bahwa penggunaan N dari urea (F1) adalah sangat rendah, terutama ditunjukkan pada tanaman total.

Kata kunci : Tiga varietas jagung, kuantifikasi pupuk, teknik N-15

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INTRODUCTION

Maize in Indonesia is considered and is used in the diversification programe besides rice the main staple diet as a source of carbohydrate. It is also a main ingredient for animal feed. The statistical year book of Indonesia [1] showed that maize is the second after rice in the case of cereal production. In South Sulawesi in 2008, maize is cultivated in an area of 96149 ha with a production of 994981 t which is equal to 38.05 quintal/ha [1]. This production is considered low and could be increase by better agricultural practices.

Usually when low production occurs the cause lay at the soil condition which mainly has declined its N-supply to plants. Many studies done in the end and early nineties forwarded that the cause of decrease in soil fertility is the deminishing of the soil organic matter (SOM) which will than decrease the soil capability for plant growth and productivity [2, 3, 4]. The wellknown study done by ADININGSIH and ROCHYATI [5] in 1988 showed clearly the correlation between lowland rice production and SOM [2]. They [5] were able to show that the decrease in SOM would decrease the rice production. In 2004 SETYORINI et al [6] classified that soil which has a SOM < 2% as low in SOM and this could cause the decrease of soil fertility.

According to G0 [7] the infertile soil in upland land are not respensive to chemical fertilizers. He[7] further stated that such soils has lost their ability to supply nutrients to plant roots. This is in relation that such soil has became degenerated in their soil microbiology activity and SOM. The lost of SOM in his[7] expression is hungry for SOM and will cause tremendouslost of chemical (anorganic) fertilizers, when added. Further this could increase environment pollution and stop the waterflow in irrigation channels. The need for the soil to build N-organic could be supplied by organic fertilizers such as manure, green manure etc. SISWORO et al [8, 9] have shown that green manure added to upland and lowland rice could increase plant production whether in combination with or without urea. MULYATRI [10] has quoted TISDALE who has shown the high ammounts needed by maize during its growth. The Data shown is as follows :

	kg N/ha/day	kg P/ ha/day
20 – 30 days	1.50	0.15
30 – 40 days	6.00	0.60
40 – 50 days	7.40	0.90
50 – 60 days	4.90	0.80

This showed the high need of N by maize compared to P. If calculated further the N need would be 15+60+74+49 kg N/ha = 198 kg N/ha. This is equal to 450 kg urea/ha up to 60 days. This large amount of urea when actual used could create plenty soil troubles as has been mentioned before. So it has to be carefully used at lower rates and supplied if possible by organic fertilizer as will be done in this study.

The use of N-15 technique by labelled fertilizer or green manure and other nutrient have been done since 1970 by Batan. The N-15 method use was for calculating the N-fertilizer whether 100 % anorganic or organic, or combination of both [8, 9, 11, 12, 13, 14, 15], the uptake by fish through feed [16], for pollution decrease in the environment by threes and shurbs [17].
In this study the N-15 method is employed to study the uptake of N in anorganic and organic fertilizer and soil and their combination by three maize varieties.

MATERIALS AND METHODS

Plant material

The plant material used were three maize varieties, namely, Anoman (A), Lamuru (L) and Sukmaraga (S). These varieties are commoncultivated by farmers in South Sulawesi.

Fertilizers supplemented

The fertilizers used and their rates are,
F0 = without fertilizer N

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F1 = 100% anorganic fertilizer in the form of urea at a rate 300 kg/ha (125 kg N/ha)
F2 = 100% organic fertilizer in the form of compos at a rate as in F1
F3 = combined anorganic and organic fertilizers at a rate of 50 % of F1 + 50% of F2.
Each pot was added with a basal fertilizer of P and K at a rate of 100 kg SP-36/ha and 100 kg KCl/ha respectively.

Plant containers

Plant containers used were plastic pots of 20 l in volume. Each pot was filled with 10 kg air-dried soil. The soil was taken from the field experiment of Agriculture Faculty located at Hasanuddin University, having an pH of 6.5, N = 0.1615 %, P_2O_5 = 0.0582mg/ 100g soil and K_2O = 0.0526mg/100g soil respectively.

Parameters observed

The plants were harvested when the panicles formation were nearly finished. The early harvesting was done to prevent the plants to be destroyed by pest. The parameters obtained were, dry weight (g) of stem, leaves, panicle and whole plant. The whole plant was : stem + leaves + panicles. Other parameters were about nitrogen (N) and were, percentage of N-derived from fertilizer (% N-F), and soil (% N-S) of the three plant parts as mentioned for dry weight and the whole plant. Further the total N-uptake (N to-uptake), N-F and N-S uptake of the three plant parts and the whole plant. Other data collected but not considered as parameters are, percentage of atom excess (% a.e.), percentage of N-15 (% N-15) and percentage of N-total (% N-to) of all three plant parts. The data is presented in Table 1.

Statistics applied

A randomized block design (RBD) was applied for the data collected. The treatments carried out were maize variety with three levels e.g., Anoman (A), Lamuru (L), and Sukmaraga (S). Fertilizers with four rates : without N-fertilizer (F0), 100% anorganic fertilizer (F1), 100% organic fertilizer (F2), 50% anorganic fertilizer + 50% organic fertilizer (F3). The codes of the treatments and their interaction are,

	A	L	S
F0	AF0	LF0	SF0
F1	AF1	LF1	SF1
F2	AF2	LF2	SF2
F3	AF3	LF3	SF3

Each treatment was replicate three times. An ANOVA was done to analyze the data. The data analyzed are presented in Tables 2 to 7.

N-15 analysis

Plant material was dried oven at 70ºC for 24 hours and than ground finely. One gram plant sample went through the Kjeldahl process for determination of N-total. After that the same solution was used for the percentage of N-15 atom excess (a.e.) by the N-15 analyze (No 1 – 6 PC).

RESULTS AND DISCUSSION

Percentage of total nitrogen (%N-to), atom excess (% a. e) and N-15 (%N-15) instem, leaves, panicles of three maize varieties

The % N-to, % a.e, and % N-15 data are presented in Table 1. The data were not statistical analyze due it would not be used in discussion. Although not analyzed it has to presented due the important of their use to be able to quantity the other data presented in Table 2 to 7. The % a.e. is derived from samples through the N-15 analyzer. After obtaning the % a.e values, the % N-15 could be calculated by deviding the % a.e of samples by % a.e of the urea N-15 labelled used in this study. If % a.e. sample = a, and % a.e. urea N-15 labelled = b (% a.e. of fertilizers are always printed in the containers which is derived from the producers). The % N-15 = a/b x 100%. With % N-15 obtained then the % N derived from N-fertilizer (%N-F) applied and % N

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derived from soil (% N-S) could be quantified.

In this study the %N-F and N-S are determined by using the N-15 technique through the A-value method. The detailed discribtion of obtaining % N-F and % N-S by A-value method could be perused in SISWORO *et. al.* [17].

From Table 1 the most important data is % a.e. in the sense that all the quantification % N-F and % N-S and further calculation depend on the % a.e. Particularly the values of % a.e F0. it should always be higher then the other fertilizer N-15 fertilizer will be diluted by N-F + N-S. Here it is assumed N-15 fertilizer diluted only by N-S resulted in higher % a.e. compared to when it is diluted N-F + N-S by the fact that the N used to diluted N-15 fertilizer of N-F + N-S is much larger in amount than only N-S. The %N-to is presented in Table 1 only show that there could be difference in N-to uptake by the different maize varieties. But it has to be reminded that high % N-to would not necessarily resulted in high N-to uptake as will be shown in the following Tables.

Table 1. Percentage of total nitrogen (%N-to), atom excess (%a.e.) and N-15 (%N-15) in stem, leaves and panicles of three maize varieties.

Fertilizers	Stem				Leaves				Panicles			
	Varieties				Varieties				Varieties			
%N-to	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F0	0.8507	1.1844	0.9679	1.0010	1.3179	1.6492	1.7360	1.5677	1.6389	1.2546	1.6565	1.5167
F1	1.1817	1.2376	0.9483	1.1255	2.2885	2.3259	2.0048	2.2064	1.5504	1.8368	1.6436	1.6769
F2	0.7364	0.7653	0.6384	0.7134	1.6408	1.1803	1.4168	1.4126	1.4508	1.4592	1.1471	1.3254
F3	1.0926	0.9482	1.4150	1.0609	2.0561	1.9404	1.8023	1.9329	1.5727	1.3626	1.2653	1.4002
Ro-V	0.9654	1.2839	0.9240	-	1.8258	1.7740	1.2894	-	1.5532	1.4783	1.1180	-
%a.e	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F0	3.9520	3.8470	3.7020	3.8340	3.5480	3.7930	3.7960	3.7120	3.9090	3.8380	3.7960	3.7120
F1	2.6930	2.7910	2.7970	2.7540	2.4440	2.7200	2.8020	2.6550	2.8240	2.8240	2.8020	2.6550
F2	2.7670	2.7120	2.9220	2.8000	2.3790	2.6540	2.7150	2.5820	2.9010	2.9010	2.7150	2.5820
F3	3.3460	3.1960	2.7070	3.0830	2.6050	3.0040	3.0010	2.8760	2.8910	2.8910	3.0010	2.8760
Ro-V	3.1900	3.1320	3.0320	-	2.7440	3.0430	3.0790	-	2.7440	3.0430	3.0790	-
%N-15	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F0	0.7556	0.7356	0.7018	0.7330	0.6822	0.7253	0.7258	0.7111	0.7475	0.7338	0.7268	0.7300
F1	0.5148	0.5298	0.5347	0.5264	0.4764	0.5201	0.5357	0.5107	0.5400	0.5147	0.5185	0.5444
F2	0.5290	0.5822	0.5587	0.5566	0.4548	0.5585	0.5190	0.5108	0.5547	0.5765	0.5611	0.5641
F3	0.6398	0.6099	0.5177	0.5891	0.5098	0.5743	0.5537	0.5459	0.5527	0.5878	0.5565	0.5907
Ro-V	0.6092	0.6144	0.5797	-	0.5308	0.5946	0.5836	-	0.5987	0.6182		

- %N-to is obtained by Kheyldahl method, %a.e. of samples is read by the N-15 analyzer and %N-15 is values of %a.e. devided by the %a.e of the N-15 fertilizer.

Notes : Varieties, Anoman (A), Lamuru (L), Sukmaraga (S).
Fertilizers : F0 = without fertlizer N, F1 = 100% anorganic fertlizer N and F3 = 50% anorganic fertlizer N + 50% organic fertlizer. These notes are valid for all the following Tables.

%a.e. treatments (F1, F2, F3). If the F0 is smaller than F1 or F2 or F3 then the A-method could not be applied [18].

Why it is assumed that F0 should be always higher than other treatments where N-fertilizer is applied ? The explanation is as follows. In F0 where no N-F is added the N-15 labelled fertilizer is only diluted by N-S. While for treatments where N-F is added the

Percentage of N-derived from fertilizers (%N-F) and soil (N-S)

Perusal of Table 2 showed that, among the treatments difference for %N-F was only shown in the stem, while for leaves and panicles no difference were found. Looking further into each treatment it showed that for the varieties difference % N-F is only shown by leaves and panicles. It could be that the N distributions form stems has not reach the leaves and panicles yet. For the plant parts the var. Anoman (A) showed the highest %N-F, followed by Sukmaraga (S) and the lowest was for Lamuru (L). From this data it could be suggested that var. A is the variety which could have used the most of the fertilizers added or is more efficient in using fertilizer N. F1 (100% anorganic fertilizer/urea) obviously has the highest % N-F for all plant parts. It could be that urea as well known will make its N-available as soon at it touch the soil. This early N availability could have cause earlier N-uptake and this could have been the reason why F1 has the highest % N-F compared to F2 (100% organic) and F3 (50% anorganic + 50% organic). From previous quatation in introduction the organic fertilizer was expected to have more change to be taken up by plants. But it is to bear in mind that organic fertilizers needed time to release their N compared to urea. This could have been the cause why it was taken up beneath urea due to its slow N release. But on the other hand the N organic fertilizers could be considered as slow release N fertilizers and this would be better for the plants, to have N-available as nearly as far as at harvest time. The Interaction between V and F (VF) showed only differences for their %NF in the stem and not in leaves and panicles. It might be no difference in N-up take by varieties or in other words they will response equal to the same levels of N-fertilizer added. The % N-S, as in % N-F for the varieties (V) showed significant difference only in leaves and panicles. While for the F treatments all the plant parts showed significant difference for % N-S. For the interaction (VxF) only the panicles having differences for % N-S. Data clearly showed that for the varieties for all the plant parts high % N-F will result in lower N-S. See for example variety Anoman (A) which have the highest % N-F, it will then show

Table 2. Percentage of N-derived from fertilizers (%N-F), N-derived from soil (%N-S) in stem, leaves and panicles of three maize varieties.

Fertilizer	Stem				Leaves				Panicles			
	Varieties				Varieties				Varieties			
%N-F	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F1	31.81	28.00	24.32	28.04	31.70	28.34	25.99	28.68	27.77	21.67	28.76	26.07
F2	31.14	20.84	22.70	24.89	33.27	22.94	28.24	28.15	25.70	21.43	22.77	23.30
F3	16.76	17.08	26.76	20.20	26.85	20.71	23.62	23.73	26.30	21.10	23.36	23.59
Ro-V	26.57	21.91	24.60	-	30.61	23.99	25.94	-	26.59	21.14	24.96	-
	F-Calculated		F-table		F-Calculated		F-table		F-Calculated		F-table	
			0.10	0.05			0.10	0.05			0.10	0.05
Treatments	4.341^{*}		2.00	2.59	1.906^{ns}		2.00	2.59	1.919^{ns}		2.00	2.59
V	2.251^{ns}		2.67	3.63	3.964^{**}		2.67	3.63	5.089^{**}		2.67	3.63
F	6.587^{**}		2.67	3.63	2.538^{ns}		2.67	3.63	1.668^{ns}		2.67	3.63
VxF	4.263^{**}		2.33	3.01	0.562^{ns}		2.33	3.01	0.920^{ns}		2.33	3.01
Replicates	0.311^{ns}		2.67	3.63	0.817^{ns}		2.67	3.63	3.754^{**}		2.67	3.63
CV (%)	18.92				19.07				14.52			
%N-S	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F0	96.91	99.26	99.29	98.49	99.32	99.27	99.27	99.29	99.26	99.27	99.27	99.27
F1	67.68	71.47	75.14	71.43	67.83	71.14	73.31	70.76	73.54	77.76	70.72	74.01
F2	69.37	78.58	78.40	75.45	66.27	76.50	71.25	71.34	74.54	77.99	76.80	76.18
F3	75.86	82.31	72.73	79.66	72.65	77.72	75.83	75.40	76.41	78.32	76.08	76.94
Ro-V	79.48	82.91	81.39	-	76.52	81.16	79.91	-	80.94	83.33	80.52	-
	F-Calculated		F-table		F-Calculated		F-table		F-Calculated		F-table	
			0.10	0.05			0.10	0.05			0.10	0.05
Treatments	9.428^{**}		1.88	2.23	26.447^{**}		1.88	2.23	27.358^{**}		1.88	2.23
V	0.844^{ns}		2.56	3.34	3.870^{**}		2.56	3.34	2.653^{*}		2.56	3.34
F	30.741^{**}		2.35	3.05	92.462^{**}		2.35	3.05	88.962^{**}		2.35	3.05
VxF	1.633^{ns}		2.06	2.55	0.965^{ns}		2.06	2.55	4.791^{**}		2.06	2.55
Replicates	0.596^{ns}		2.56	3.34	0.976^{ns}		2.56	3.34	2.435^{ns}		2.56	3.34
CV (%)	7.97				5.34				4.62			

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the lowest % N-S, while for var. L showed the highest % N-S but the lowes % N-F.

For fertilizers treatments F1 which has shown the highest % N-F compared to F2 and F3 then showed the lowest % N-S compared to the two other treatments (F2, F3). This is due to the need of the plants for any nutrient, where it nutrients has been saturated by one source it will then take less from another source/second source. The difference among the fertilizer treatments is assumed to be to the large difference between F0 (without any N fertilizer) and F1, F2, F3 for % N-S. Here it could be calculated accurately the % N-S for F0, F1, F2, F3 by the N-15 technique.

N-total (N-to), N-derived from fertilizer (N-F), and N-soil (N-S) uptake

The N-to uptake (mg N) is the value derived from dry weight of each plant part multiply by % N-to (see Tables 1 and 4). While the N-F and N-S uptake are the result of N-to uptake values times % N-F or % N-S respectively (Tables 2 and 3). Both units are in mg N. The large or lesser amount of N-to uptake depend on the amount of dry weight and %N-to. So high %N-to could not be expected to result in high N-to uptake, but depends on the dry weight gained and the reverse could happened. Where large dry weight could not guarantee high N-to uptake.

The data of N-F uptake presented in Table 3, showed that there were differences for N-F uptake for stem and panicle by the applied N-F. The highest value for N-F uptake was found in F1, for all three plant parts, although for the leaves it show no significant difference. For the varieties no significant difference was found in stem and leaves, and only in panicles difference appeared for the N-F uptake. Not like in the F-treatment where constantly highest N-F uptake is shown by F1, for the varieties this just varied. For stems the highest N-F uptake was shown by var. Sukmaraga (S), while for leaves and panicles this was shown by var. Anoman (A).

The interaction (VxP) showed that interaction F1xV has always higher values than F2xV and F3xV as also shown for the single factor F, where F1 is higher compared to F2 and F3 in N-F uptake. As mentioned before the urea applied (F1) has a very early N-availability compared to organic fertilizer (F2) and 50% + 50% organic and anorganic (F3). This explained the larger N-F uptake in F1 compared to F2 and F3. Apparently the N-F uptake is still accumulated in the leaves and has not yet been distributed to the panicles. This is assumed to be due the early harvest, which was done when panicle formation nearly ended and cobs has not yet been formed,. It could be speculated that when harvest was carried out at the usuall harvest time for maize the N accumulated in the leaves should have been distributed largely to the end product of the maize plant.

The N-S uptake showed that for all the plant parts the treatment F showed differences among the rates. The reverse is shown for treatments V.Further for VxP and the treatments where no difference was found. The Interaction (VxF) and treatment in the panicles like in N-F uptake, the highest N-S uptake is shown by F1 for stems and leaves but not for panicles. For the panicles the highest N-S uptake was shown by F0. It could be that in the F0 treatment the N-S uptake had been distributed earlier to the panicles than the other F treatments (F1, F2, F3).

The phenomena of F1 taken up N-S more then F0 in stem and leaves could be due to the plants receiving F1 treatment was able to grow their roots luxuriantly. This happened in several experiment by Batan [19, 20], where placement of fertilizers whether N, P, or K could increase the root growth tremendously at the location where the fertilizers were placed. Obviously this has happend too in this study, where F1 (urea) could have stimulate root growth to greater extence compared to F2 and F3, due to its early N-availability. This luxuriant root growth apparently was able to contact a lot

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Table 3. N-derived from fertilizer (N-F), N-derived from soil (N-S), N-total (N-to) uptake and dry weightofstems, leaves and panicles of three maize varieties.

Fertilizer	Stem				Leaves				Panicles			
	Varieties				Varieties				Varieties			
N-F (mgN)	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F1	45.44	53.95	45.69	48.27	89.40	78.88	87.47	85.25	17.34	12.91	20.01	16.75
F2	22.98	22.68	23.57	23.07	58.38	50.53	48.95	52.55	12.73	11.96	9.74	11.48
F3	16.84	22.82	35.64	25.10	65.85	49.49	45.27	53.54	18.03	9.18	9.49	12.23
Ro-V	28.41	33.14	34.89	-	71.21	59.57	60.57	-	16.03	11.35	13.08	-
	F-Calculated		F-table		F-Calculated		F-table		F-Calculated		F-table	
			0.10	0.05			0.10	0.05			0.10	0.05
Treatments	2.772**		2.00	2.59	1.021^{ns}		2.00	2.59	4.512**		2.00	2.59
V	0.529^{ns}		2.67	3.63	0.421^{ns}		2.67	3.63	4.683**		2.67	3.63
F	9.257**		2.67	3.63	3.494*		2.67	3.63	6.789**		2.67	3.63
VxF	0.652^{ns}		2.33	3.01	0.085^{ns}		2.33	3.01	3.289**		2.33	3.01
Replicates	0.389^{ns}		2.67	3.63	1.789^{ns}		2.67	3.63	1.694^{ns}		2.67	3.63
CV (%)	42.94				48.80				24.36			
N-S (mgN)	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F0	103.28	117.41	106.17	109.15	134.33	123.12	118.71	125.52	48.77	46.39	54.94	50.03
F1	93.26	141.14	141.26	125.22	178.86	187.65	258.92	208.48	43.04	46.11	51.48	46.88
F2	42.42	76.44	86.38	68.41	115.04	167.04	121.08	134.39	36.03	43.77	32.36	37.39
F3	92.12	117.47	90.11	99.90	177.04	172.44	141.43	163.64	51.55	29.57	33.33	38.15
Ro-V	82.77	113.12	106.13	-	151.42	162.56	160.04	-	44.85	41.46	43.03	
	F-Calculated		F-table		F-Calculated		F-table		F-Calculated		F-table	
			0.10	0.05			0.10	0.05			0.10	0.05
Treatments	1.567^{ns}		1.88	2.23	1.879^{ns}		1.88	2.23	3.014**		1.88	2.23
V	2.094^{ns}		2.56	3.34	0.182^{ns}		2.56	3.34	0.490^{ns}		2.56	3.34
F	3.577**		2.35	3.05	4.576**		2.35	3.05	5.091**		2.35	3.05
VxF	0.397^{ns}		2.06	2.55	1.353^{ns}		2.06	2.55	2.817*		2.06	2.55
Replicates	0.854^{ns}		2.56	3.34	0.331^{ns}		2.56	3.34	0.505^{ns}		2.56	3.34
CV (%)	37.79								19.46			
N-to (mgN)	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F0	105.39	118.33	107.53	110.42	135.66	124.02	119.58	126.42	49.14	46.74	55.37	50.41
F1	139.42	196.10	187.71	174.41	269.49	267.91	334.09	290.50	61.08	59.35	72.84	64.42
F2	75.48	97.61	110.57	94.55	174.21	218.60	170.92	187.91	48.69	56.05	41.88	48.87
F3	109.65	140.94	126.43	125.67	244.14	224.45	187.40	218.83	70.77	43.50	43.91	52.72
Ro-V	107.48	140.94	133.06	-	205.87	208.87	203.00	-	57.41	51.41	53.50	-
	F-Calculated		F-table		F-Calculated		F-table		F-Calculated		F-table	
			0.10	0.05			0.10	0.05			0.10	0.05
Treatments	1.756^{ns}		1.88	2.23	2.679**		1.88	2.23	2.752**		1.88	2.23
V	1.517^{ns}		2.56	3.34	0.021^{ns}		2.56	3.34	0.934^{ns}		2.56	3.34
F	4.321**		2.35	3.05	8.579**		2.35	3.05	3.757**		2.35	3.05
VxF	0.554^{ns}		2.06	2.55	0.615^{ns}		2.06	2.55	2.858**		2.06	2.55
Replicates	0.319^{ns}		2.56	3.34	0.851^{ns}		2.56	3.34	3.754**		2.56	3.34
CV (%)	36.68				33.94				20.18			
Dry weight(g)	A	L	S	Ro-F	A	L	S	Ro-F	A	L	S	Ro-F
F0	12.63	11.38	10.38	11.46	10.72	8.00	6.96	8.56	3.03	3.74	3.44	3.40
F1	13.53	16.24	19.88	16.55	11.38	11.28	16.89	13.18	3.93	3.24	4.44	3.87
F2	10.74	13.22	18.63	14.20	10.58	11.76	12.27	11.54	3.44	3.87	3.65	3.63
F3	11.82	15.38	11.33	12.84	11.92	11.61	10.48	11.34	4.44	3.20	3.47	3.71
Ro-V	12.18	14.06	15.05	-	11.15	10.67	11.65	-	3.40	3.87	3.65	-
	F-Calculated		F-table		F-Calculated		F-table		F-Calculated		F-table	
			0.10	0.05			0.10	0.05			0.10	0.05
Treatments	1.258^{ns}		1.88	2.23	1.645^{ns}		1.88	2.23	4.787**		1.88	2.23
V	1.096^{ns}		2.56	3.34	0.275^{ns}		2.56	3.34	1.548^{ns}		2.56	3.34
F	1.807^{ns}		2.35	3.05	3.122^{ns}		2.35	3.05	2.625*		2.35	3.05
VxF	1.089^{ns}		2.06	2.55	1.363^{ns}		2.06	2.55	6.949**		2.06	2.55
Replicates	2.888*		2.56	3.34	0.750^{ns}		2.56	3.34	1.879^{ns}		2.56	3.34
CV (%)	35.06				29.16				9.78			

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Table 4. N-derived from fertilizer uptake (N-F uptake). N–soil uptake (N-S uptake). N-total uptake (N-to uptake) and dry weight of the whole plant shown by three maize varieties (mg N).

Fertilizers	N-F uptake (mg N)				N-S uptake (mg N)			
	Varieties				Varieties			
N-F	A	L	S	Ro - F	A	L	S	Ro - F
F0	-	-	-	-	286.78	286.92	280.42	284.71
F1	152.15	145.71	85.01	127.62	321.84	374.90	451.65	382.80
F2	87.24	82.89	40.42	70.18	193.49	287.25	236.50	239.08
F3	100.73	81.30	30.75	70.93	320.72	319.48	264.87	301.69
Ro-V	113.37	103.30	52.06	-	280.71	317.14	308.36	-
	F-calculated		F-table		F-calculated		F-table	
N-S			0.10	0.05			0.10	0.05
Treatments	2.123*		2.00	2.59	2.199*		1.88	2.26
V	4.170**		2.67	3.63	0.739ns		2.56	3.34
F	4.188**		2.67	3.63	5.510**		2.35	3.05
VxF	0.066ns		2.33	3.01	1.030ns		2.06	2.55
Replicates	0.313ns		2.67	3.63	0.364ns		2.56	3.34
CV (%)	53.93				25.40			
NTO								
N-F								
F0	286.78	286.92	280.42	284.71	26.39	23.13	20.78	23.43
F1	469.97	523.37	594.65	529.33	28.85	30.76	41.20	33.61
F2	301.05	376.90	323.37	333.73	25.41	28.51	34.52	29.59
F3	423.92	409.97	355.08	396.32	27.40	30.19	25.27	27.62
Ro-V	284.71	529.33	333.70	-	27.01	28.23	30.44	-
	F-calculated		T-Table		F-calculated		F- Table	
Treatments	2.679**		1.88	2.26	1.751ns		1.88	2.26
V	0.219ns		2.56	3.34	0.729ns		2.56	3.34
F	8.661**		2.35	3.05	3.234**		2.35	3.05
VxF	0.508ns		2.06	2.55	1.350ns		2.06	2.55
Replicates	0.253ns		2.56	3.34	2.144ns		2.56	3.34
CV (%)	27.96				24.71			

Whole plant in this experiment is all the above plant parts which is : stem + leaves + vanicles

of soil particles and this then resulted in high N-S uptake surpassing even the F0 treatment in stem and leaves. The N-S uptake by the varieties do not show constantly the same trend. For the stems var. Lamuru (L) showed the highest N-S uptake, while for leaves and panicles it is shown by var. Sukmaraga (S) and var. Anoman (A) respectively. The interaction of VxF showed a constant trend where VxF1 in general have higher values compared to the other interaction (VxF0, VxF2, VxF3) for stem and leaves but not for panicles. It is assumed that higher values of VxF1 compared to the other interaction was due to the high N-S uptake and not to the varieties

As N-to uptake is the sum of N-F uptake added by N-S uptake, it is not supprising that the F treatment uniformily showed differences for all three plant parts. Apparently the difference in N-F and N-S uptake in all three plant parts is inherit by the N-to uptake. For all plant parts the F1 treatment constantly showed higher values above F0, F2, F3. For F3 although having lower N-to uptake compared to F1, but is constantly higher than F0, while this was not shown for F2. The high N-to uptake by F1 could be explained as already explain previously is due to the early release of N by urea. For F3, it could that the 50% anorganic fertilizer (urea) has the same effect as in F1 but at a lower scale. While for F2 100% organic fertilizer the low N-to uptake is usually due to the slow release of N. It is wellknown organic fertilizer needs a certain decomposing time to be able to release it nutrients. But this is only the first used of organic fertilizer. Field studies done by Batan [8, 9] using green manure/organic fertilizer in lowland for three seasons and six seasons in upland areas showed that the plant production receiving organic fertilizer were better than the ones which have received anorganic fertilizer. The reason is that the soil organic matter (SOM) was improved by long application of organic matter. This will further improved soil fertility with the end result inincrease plant production.

Besides that organic fertilizer could be considered slow release fertilizer, meaning that it hopefully would be able to provide nutrient, as long as towards harvest time.

For the varieties no constant of values was shown as in N-F and N-S uptake. The highest N-to uptake in stems and leaves was shown by var. Lamuru (L), the lowest for the stem was for var. Anoman (A), leaves shown by var. Sukmaraga (S) and for panicles by var. Lamuru (L). For all the treatments, F, V, VxF, the highest N-to uptake were found in leaves. As has been mentioned before this is due to that large part of N-to has not been distributed yet to the panicles due to early harvest of the plants.

Dry weight of the plant parts all showed that the F1 treatment give the highest dry weight value and significant different were found except for stem dry weight all the other F treatment (F2, F3) showed higher dry weight compared to F0. For the varieties like in the other parameters no constant trend is found. For the interaction, the interaction of VxF1 is constantly higher in dry weight compared to the other interaction. From this data it could be said that the fertilizer treatment has more influence on the end product which is dry weight than the varieties it self. A clearer and comprehensive of all the treatments and parameters could be shown by the whole plant which is the sum of all three plant parts (stem + leaves + panicles), as will be shown in further discussion.

N-fertilizer (N-F), N-soil (N-S) and N-total (N-to) uptake by whole plants

The whole plant in this discussion is the above ground part of the plants. Here the whole plant is considered the addition of all three plant parts (stem + leaves + panicles) which have been analyzed separately.

The data in Table 4, showed that the highest N-F uptake, N-S uptake, N-to uptake and dry weight was found in treatment F1 while for treatments F2 and F3, the N-F uptake showed small difference. For N-S uptake and N-to uptake F3 showed higher values than F2 but for dry weight it was the reverse.

For the F treatments, the F1 treatment difference significantly from F2 and F3, showing that the N-F uptake of F1 was around 1.8 times more than F2 and F3. For the N-S uptake the significant difference of F1 to the other treatments, especially compared to F0 and F2 was shown. It showed that N-S uptake of F2 was beneath that of F0. This could be to the fact that the 100% organic fertilizer its N was not easily as available as the 100% anorganic fertilizer (F1) and the 50% anorganic + 50% organic fertilizers (F3). The advantage and disadvantage of these fertilizers would be discused in the next section. Among the varieties the several N-uptakes (N-F, N-S and N-to) showed no constant trend. Var. Anoman (A) has the highest N-F uptake but the lowest in N-S and N-to uptake, and this result in the lowest dry weight. The second in rank of N-F uptake was by var. Lamuru (L), but has the highest N-S and N-to uptake, but has the second in rank for dry weight. Further var. Sukmaraga (S) it has the lowest

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N-F uptake, the second in rank N-S uptake and N-to uptake, but has the highest dry weight. To have a clearer look about the ranking among the treatments as follows : N-F uptake A > L > S, N-S uptake L > S > A, N-to uptake L > S > A, dry weight S > L > A. From the ANOVA it could be perused that the differences in N-F, N-S, N-to uptake and dry weight was significantly influenced by the F treatments, while for the V treatments mostly showed no differences. If any differences occured for the treatments or the interaction (VxP) mostly it was influenced by F treatments. Attention has to paid for the data of N-S uptake compared to N-F uptake and its importance to N-to uptake and dry weight. Obviously from data in Table 5 the N-S uptake was for above the N-F uptake for all treatments (F, V, VxF). The N-S uptake will further influence the high or low N-to uptake and dry weight. This meant that the plants have benefit more of N-soil than N-fertilizer. This is assumed to be due to three reasons, (1) the N from fertilizer were slow in their N-available, and (2) the rates of the fertilizers was not high enough to satisfy the plants needs. Reason no 1, might be true for F2 (100% organic), and F3 (50% anorganic + 50% organic), where the N-organic usually is slow in its N release, but not for 100% anorganic in the form of urea (F1) this would be denied, due to the characteristic of urea which is able to release its N as soon as it tough the soil.

So the no 2 reason could be accepted. On the other hand increasing the rates of fertilizers N especially the anorganic sort has worse consequences upon the soil. According to Go [7] the main reasons why soil does not response to anorganic fertilizers are the decrease of biology activities and the soil organic matter. In the end lower biological activity and soil organic matter will result in low plant growth and production. If in the future the anorganic fertilizer want to be used after this study and further studies, careful consideration has to be taken into account especially for the rates of application. The other reason of the disadvantage of exhausting the N-Soil is that to refill the N-soil will take along time. Besides that the lower the N-soil the less fertile the soil become.

In this study it showed that the high soil uptake will result in high N-to uptake and dry weight. It might look that treatment F1 is the most beneficial for plant growth and production, but in the long range the consequences would be worse as mentioned by Go [7]. The total organic fertilizer used could be the solution of the decrease of soil fertility which will expressed in low growth and production. Work done by SISWORO *et al* [8] on upland soil using upland rice and maize for six seasons and using total organic fertilizers showed good result. For the first seasons the growth and production of plants applied with total organic fertilizer did not exceed the plants given total anorganic fertilizer, but in the last seasons of the experiment the growth and production of plants applied with total organic fertilizers could equal and in some seasons even surpassed the growth and production applied with total anorganic fertilizer.

Beside that the organic fertilizer (F2) could be considered as a slow N-release fertilizer. This slow release of N should be beneficial to the plants, meaningit could supply N up to late plant growth even up to harvest time. The factor to be considered is that organic fertilizers in the long range has the ability to preserve the soil fertility and have capability to increase growth and production as has been shown by ANUGERAH *et al* [21]. He [21] recomended six rules to increase lowland rice and one of these rules, is use only organic fertilizers (compost). It might be worthwhile to use and recommended it to farmers.

Percentage derived from fertilizers (% N-F) and derived from soil (% N-S) in the whole plant

In fertilizers studies using the N-15 methodology it is common to expressed the N-F and N-S uptake in percentage. This is due to values in percentage (%) are easier to read and to be expressed about the differences in fertilizer and soil uptake than for example values in mg/g etc. In Table 5, the highest % N-F, with other word the most taken up N-F is for F1 treatment. As mentioned before this might be due to the early N-availability by urea, which is the N-source for F1. This meant that the plants would use N as soon as they have contact with the roots. That plant roots could take up nutrient as soon as roots occured was shown by SISWORO [22]. Using lowland rice seedlings, he [22] showed that the seedlings could take up P, in the form of P-32, 24 hours after the P-32 application. This would be happening too for other nutrients, such as N and K when their are available. On the other hand 24.22% uptake of N in urea is considered low. This number when used to calculate the N-loss, the loss would be around 75.78%.

fields are due to, (1) easily lost in surface run of, (2) easily lost to leaching to deeper soil depths, making it not possible for annual crops to be used, (3) lost by volatilization. While for F2 and F3, the N loss possibility is just the same as for F1. The beneficial of having organic fertilizers 100% (F2) and 50% (F3), that the N was slowly available, so the losses were slower too. The lower percentage of N-F uptake of F2 and F3, is assumed to be due to it slow N availability as has been mentioned previously.

For the varieties the % N-F showed differences among them. The ranking from the highest to lowest values of N-F is var. Anoman (A) > var. Lamuru (L) > var. Sukmaraga (S). Whether this means that there are differences among the varieties responding to N-fertilizer has to be studied

Table 5. Percentage of N-derived from fertilizer (%N-F) and soil (%N-S) in the whole plant [2)] of three maize varieties

Fertilizer	%N-F				%N-S			
	Varieties				Varieties			
N-F	A	L	S	Ro-F	A	L	S	Ro-S
F0	-	-	-		99.27	98.73	99.28	99.09
F1	31.36	27.80	14.11	24.22	66.26	71.68	78.85	71.26
F2	28.27	21.66	12.78	20.90	65.17	76.06	74.46	71.90
F3	23.71	19.62	8.45	17.26	73.57	78.47	75.10	75.71
Ro-V	27.78	23.02	11.78	-	76.07	81.24	81.17	-
	F-Calculated		F-table		F-Calculated		F-table	
N-S			0.10	0.05			0.10	0.05
Treatments	6.858^{**}		2.00	2.59	43.906^{**}		1.88	2.23
V	22.750^{ns}		2.67	3.63	9.991^{**}		2.56	3.34
P	4.320^{**}		2.67	3.63	148.849^{**}		2.35	3.05
VxP	0.180^{ns}		2.33	3.01	2.739^{*}		2.06	2.55
Replicates	0.155^{ns}		2.67	3.63	4.303^{**}		2.56	3.34
CV (%)	24.78%				4.09%			

2) whole plant = stem + leaves + panicles

This number is high above the number presented by IAEA [23] before recommendation to improve cultivation practices. IAEA [23] stated that in the field urea loss was 30-50% by Asian farmers using the non improved cultivated practices. Great N-losses when urea is applied in the more thoroughly. If this fact is tree, varieties responsive to N fertilizers could be recommended to be used in the field. The differences among the F treatments for %N-S is of course due to F0 (without N fertilizer) which showed the highest value. For the varieties the differences would be due to the

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variety which has the highest % N-F. The higher the % N-F, the lower the % N-S. This then showed in the ranking of % N-S, which is: A < S < L.

The interaction of the treatments (VxP) is mostly due to the F treatment. The F treatments are speculated to be more responsible for the difference in the treatments interaction (VxF) compare to the V treatments.

CONCLUSIONS

From this study involving N from different sources and three different maize varieties where the N-15 technique was applied, the following can be concluded :

1. The first rule to be able to use the N-15 technique by involving to the A-value method, which is the percentage atom (% a.e.) of the N-15 found in plant samples of plants not receiving N-fertilizers at all (F0) has to be higher than plants receiving N-fertilizers (F1, F2, F3) was fullfilled. The % a.e. of F0 was above all the % a.e. of F1, F2, F3.
2. The N-derived from fertilizer (N-F) and soil (N-S) especially expressed in percentage (%) of the three plant parts : stem, leaves, panicles, and whole plant (stem + leaves + panicles) have been determined quantitavely using the N-15 technique.
3. The highest values of N-F, N-S, N-total (N-to) in the three plant parts and whole plant expressed in percentage (%), N-uptake (mg N) and dry weight (g) were found in F1 treatment (F1 > F0, F2, F3). While for among the varieties significancy does not a constant trend.
4. The difference in treatments and interaction found in some plant parts or whole plant apparently was due to F treatment and not V treatment.
5. Data of this study showed that the N-soil obviously play a important role on all the parameters studied. This was shown that the contribution of N-S especially when expressed in N-to (mg N) was much above the values of N-F.
6. The urea-N (F1) showed that the plant used of this fertilizer was quite low shown clearly for the whole plant. This could be due to N-urea is easily lost and it is in fact considered as having low N-efficiency.
7. Although the 100% organic fertilizer (F2) and 50% anorganic fertilizer + 50% organic fertilizer (F3) did not exceeded the anorganic fertilizer (F1) for all parameters, it should still be kept in mind the many beneficial influence of organic fertilizer on soil fertility in the long run.

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