THE CONTRIBUTION OF AZOLLA AND UREA IN LOWLAND RICE GROWTH PRODUCTION FOR THREE CONSECUTIVE SEASONS

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ABSTRACT

THE CONTRIBUTION OF AZOLLA AND UREA IN LOWLAND RICE GROWTH PRODUCTION FOR THREE CONSECUTIVE SEASONS. Three field experiments have been carried out in three consecutive seasons namely wet season (120 days), dry season (120 days), wet season (120 days) at Pusakanegara. The purpose of this experiment is to test whether urea combined with Azolla could increase lowland rice production and soil quality. The experimental plots have a size of 20 m^2 and in each experimental plot an isotope plot was placed with a size of 1 m^2. The isotope plots were used to apply labeled ^{15}N urea. Treatments conducted were lowland varieties: Atomita I (V1) and IR-64 (V2); several levels of urea and Azolla : Pu1 = urea-tablets **+** an Azolla cover (Azc), Pu2 = urea-tablets **+** Azolla incorporated (Azi), Pu3 = urea-prill **+** Azc , Pu4 = urea-prill **+** Azi; seasons : Ss 1 = wet season, Ss2 = dry season, Ss3 = wet season. The experimental design used was a factorial experiment in a Randomized Block Design, where each treatment was replicated four times. Parameters used were, dry weight of straw (St), grain (G), plant (P1 = St **+** G) in kg/ha; N-total percentage (% N-to) of St and G, percentage N-derived from urea **+** Az (% N-Pu) of St and G; percentage N-derived from soil (% N-S) of St and G; uptake of N-Pu and N-S in St, G and P1. Some results of these experiment were, N-Pu play a less important role in growth of lowland crop expressed in several parameters compared to N-soil. The form of N-urea in tablets are superior to that the form of urea in prills. For the last product of lowland rice which is grain obviously V1 (Atomita-1) is better than V2 (IR-64) expressed in t/ha. The progress of seasons showed clearly that there is an N accumulation which might be the increase of soil organic matter (SOM) and that means there is an increase in soil quality in the view point of N.

Key words: Azolla, Urea, Lowland rice

INTRODUCTION

Soil is a source for natural resources which is very important for the life of mankind. Soil is the base for fulfilling the physical necessity of man such as, food, clothing, and other non physical needs. Due to soil's wide and large fungsional purpos it is so frequently exploited exceeding its capability, and the main result is damage of its physical and chemical properties [1,2, 3].

In Indonesia the most common soil damage is the diminishing of the soil organic matter (SOM) content which will cause the diminishing of soil capability for plant growth and productivity. This is in line with VERSTRATE [4] who stated that the OM rate of decomposition in wet tropical area is much faster compared to sub-tropical areas and this will result that in wet tropical areas such as Indonesia OM will disappear fast with detrimental results when not inhibited.

SOM has a vital role in the capability to support plant growth. Further SOM will influence the physical and biological properties of the soil. According to STEVENSON [5], SOM is all organic matter (OM) found in soil, including mulch, light weight OM, biomass of soil microorganism, OM dissolved in water and stable OM known under the name of humus. The soil damage due to diminishing SOM, could destroy the physical, biological properties of soil, so it could loss the capability to support plant production.

To improve the three soil properties mentioned simultaneously the best alternative is to apply OM and anorganic fertilizer [2]. Green manure is one of an OM form and could increase SOM. Because of their high N_2-fixing ability in standing water, Azolla is considered as a potential green manure.

In this paper, the use of Azolla as a green manure combined with urea done in three consequtive seasons applied to lowland rice to improve growth and production of rice and to improve soil quality is reported.

EXPERIMENTAL METHOD

Plant Materials

Plant material used were two lowland rice varietirs namely, V1: Atomita-1 and V2 : IR-64. Three weeks seedling were transplanted into the field and harvested at grain maturity and were done at three consecutive seasons Ssl (wet season) - Ss2 (dry season) - Ss3 (wet season). Each season lasted around 120 days.

Location and Experiment Plots

Location of the experiment is in Pusakanegara at the experimental Station of Department of Agriculture. Each experiment plot consisted of two parts, the large part has a size of 20 m^2 and is named yield plot and each yield plot has a plot size of 1 m^2 and is called isotope plot. In the isotope plot, the ^{15}N compound is applied, in this case it was ^{15}N labeled urea with a 10% abundance.

Treatments Apllied Experimental Design and Parameters Observed

Treatment applied in this experiment are tabulated as follow:

		Pul	Pu2	Pu3	Pu4
V1	Ssl	Azi + UT	Azc + UT	Azi + UP	Azc + UP
	Ss2	Azi + UT	Azc + UT	Azi + UP	Azc + UP
	Ss3	Azi + UT	Azc + UT	Azi + UP	Azc + UP
V2	Ssl	Azi + UT	Azc + UT	Azi + UP	Azc + UP
	Ss2	Azi + UT	Azc + UT	Azi + UP	Azc + UP
	Ss3	Azi + UT	Azc + UT	Azi + UP	Azc + UP

Azi : Azolla incorporated into the soil. Azolla was grown 3 weeks before soil preparation for transplanting, which was about three weeks, at this time it has covered the whole water surface, when incorporated it was at rate of 2 t/ha.

Azc : Azolla floated on water surface, Azolla as in Azi was grown for three weeks, and after having covered the surface of the water, transplanting was done and the Azolla cover was left covering the water surface.

The experimental design used was a factorial experiment involving a randomized block design where each treatment was replicated four times. In this factorial experiment, the treatment were season with three levels (Ss1, Ss2, and Ss3) ; lowland rice varieties (V1, V2), where V1 is Atomita-l and V2 is IR-64; N-fertilizer with four levels (Pul, Pu2, Pu3, and Pu4), and its interactions as will be shown in all the following tables. Parameters observed were dry weight of straw (St), grain (G), and plants (P1 = St + G) (kg/ha); N-total percentage (% N-to) of St and G; percentage of N-derived from urea (% N-Pu) of St and G; percentage of N-derived from soil (% N-S) of St and G; uptake of N-Pu and N-S in St, G, and P1 (kg N/ha). The % N-Pu and % N-S for St and G are taken from the isotope plots. Here the N contributed by Azolla either by Azi oir Azc is considered as N-soil because it would be mineralized and assumed contributed to the N-soil.

RESULTS AND DISCUSSION

Dry Weight

In Table 1, data presented are for dry weight of straw (St), grain (G), and plant (P1 St + G). The ANOVA showed that, for dry weight of St, G, and P1, only the total treatments and the single treatment Ss have highly significant difference, while the other treatments showed no difference among them, except for St (Pu x V x S) and P1 (V). From the ANOV A, Pu treatment, whether urea in the form of tablets added with Azolla incorporated (Azi) or as a cover (Azc), these are Pul and Pu2, and prill urea with Azi or Ac (Pu3 and Pu4) did not influence the dry weight of all the parameters observed. Based on this it could be assumed that the form of urea, either tablets or prill added with Azi or Azc has equal influences on dry weight, of St, G, P1. It could be speculated that the soil has already enough nitrogen (N) from SOM so no response was given by the lowland crop on N addition of outside sources.

Perusal of the ANOVA showed that no difference in dry weight was found between V1 and V2 in St and G, but difference was found in P1 between V1 and V2, where V1 gave higher dry weight than V2. When looking at St and G dry weight of V1 consistently showed higher values than that of V2, although not significantly different. Based on the dry weight of St, G, and P1 that there could be different between varieties in their production, in this case between V1 and V2. This should be taken into consideration when high production was sought for.

Table 1. Dry weight of straw, grain, and plants of lowland rice with several N-fertilizer levels at three consecutive

	Straw (St) – t/ha					Grain (G) – t/ha					Plants (Pl) – t/ha				
	N-Pu1	N-Pu2	N-Pu3	NPu4		N-Pu1	N-Pu2	N-Pu3	NPu4		N-Pu1	N-Pu2	N-Pu3	NPu4	
Ro-PuxVxSs															
V1 Ss1	3.505	3.354	4.020	3.854		5.526	5.363	5.488	5.801		9.031	8.717	9.513	9.653	
Ss2	4.475	4.354	4.104	4.660		7.100	6.138	6.463	6.300		11.875	10.482	10.549	10.937	
Ss3	4.994	5.260	4.923	4.732		5.906	6.617	5.443	6.142		10.850	11.876	10.366	10.874	
V2 Ss1	3.716	3.522	3.606	3.215		5.800	5.690	5.103	5.803		9.516	9.212	8.709	9.017	
Ss2	4.634	4.219	4.203	4.322		6.075	6.325	5.400	6.000		10.571	10.544	9.830	10.322	
Ss3	4.988	5.108	4.553	4.816		5.960	5.723	5.494	5.671		10.949	10.829	10.047	10.497	
Ro-Pu	4.377	4.303	4.235	4.266		6.061	5.976	5.565	5.933		10.465	10.277	9.836	10.217	
Ro-PuxV					Ro-V					Ro-V					Ro-V
V1	4.308	4.323	4.349	4.416	4.349	6.177	6.039	5.813	6.081	6.024	10.585	10.359	10.142	10.489	10.394
V2	4.416	4.283	4.121	4.117	4.242	5.945	5.909	5.332	5.825	5.754	10.345	10.195	9.529	9.945	10.004
Ro-PuxSs															
Ss1	3.610	3.438	3.813	3.534	3.599	5.663	5.527	5.296	5.802	5.572	9.223	8.965	9.111	9.336	9.171
Ss2	4.554	4.287	4.153	4.491	4.371	6.588	6.231	5.931	6.150	6.25	11.233	10.513	10.190	10.630	10.639
Ss3	4.966	5.184	4.738	4.774	4.916	5.993	6.170	5.468	5.906	5.869	10.899	11.353	10.206	10.685	10.786
Ro-VxSs	Ss1	Ss2	Ss3			Ss1	Ss2	Ss3			Ss1	Ss2	Ss3		
V1	3.683	4.398	4.094			5.545	6.500	6.027			9.229	10.961	10.991		
V2	3.515	4.094	4.866			5.599	5.956	5.712			9.114	10.317	10.580		

ANOVA										
	F-Calculated		F-Calculated			F-Table	
						5%	1%
Treatments	6.674**		1.848*			4.222**	1.685	2.095
Pu	0.425ns		2.600ns			2.241ns	2.743	4.085
V	1.299ns		3.892ns			4.887*	3.982	7.016
Ss	66.301**		7.608**			34.133**	3.133	4.928
PuxV	1.098ns		0.268ns			0.397ns	2.743	4.085
PuxSs	1.709ns		0.537ns			1.240ns	2.232	3.074
VxSs	0.127ns		1.651ns			0.751ns	3.133	4.928
PuxVxVxSs	5.494**		1.379			0.368ns	2.232	3.074
CV (%)	10.70		11.39			8.48		

Notes: - All the values are a mean of 4 replicates ; ns: not significant ; * : significant difference; ** : highly significant difference ;
- CV : Coefficient of variations

An interesting observation was shown by the treatment of seasons (Ss). For St and P1, the dry weight increase from season to season (Ss1 < Ss2 < Ss3), but not so for G. The highest dry weight was found at Ss2 (Ssl < Ss3 < Ss2). It has been mentioned in Method and Materials, that the work at Ss1 and Ss3 were done in the wet season. Apparently in the dry season (Ss2) where light intensity at dry season is much higher then in the wet season (Ss1 and Ss3) and water was enough to be used by the crop, the CO_2 fixation and all the metabolism related with it is high resulting in high grain (G) production as found in this work. From all the interaction of two treatments despite no difference was shown, most of the data were in line with the single treatment V. Thus, if dry weight of V1 >V2, then the interaction of V1 with Pu or Ss will show higher dry weight too over that of the interaction with V2.

Total-N Percentage (%N-to)

In Table 2, the ANOVA showed that, for St and G differences were found for the total treatments (**), V (**), Ss (**), VxS (**). Significant interaction was also found too for Pu x V x S (*). Only the treatments with differences especially for the interactions will be discussed.

Table 2. Total-N percentage (%N-to) of straw and grain of lowland rice applied with several levels of N-fertilizers at three consecutive seasons.

	Straw (St) %					Grain (G) %					
	N-Pu1	N-Pu2	N-Pu3	N-Pu4		N-Pu1	N-Pu2	N-Pu3	N-Pu4		
Ro-Pu x V x Ss											
V1 Ss1	0.54	0.57	0.53	0.54		1.13	1.16	1.07	1.07		
Ss2	0.60	0.56	0.57	0.54		1.12	1.15	1.15	1.18		
Ss3	0.71	0.64	0.65	0.63		1.23	1.18	1.22	1.25		
V2 Ss1	0.64	0.71	0.61	0.70		1.03	1.04	1.07	1.05		
Ss2	0.76	0.81	0.79	0.80		1.11	1.13	1.12	1.13		
Ss3	0.78	0.80	0.82	0.79		1.21	1.25	1.18	1.20		
Ro-Pu	0.67	0.68	0.66	0.66		1.14	1.15	1.13	1.13		
Ro-Pu x V					Ro-V					Ro-V	
V1	0.62	0.59	0.59	0.57	0.59	10.16	1.17	1.15	1.14	1.15	
V2	0.72	0.77	0.74	0.76	0.75	10.12	1.14	1.12	1.12	1.13	
Ro-Pu x Ss					R-o-Ss					Ro-Ss	
Ss1	0.59	0.64	0.57	0.62	0.60	1.08	1.10	1.07	1.06	1.08	
Ss2	0.68	0.68	0.68	0.67	0.68	1.12	1.14	1.14	1.12	1.13	
Ss3	0.75	0.72	0.73	0.71	0.73	1.12	1.22	1.20	1.22	1.21	
Ro-V x Ss	Ss1	Ss2	Ss3			Ss1	Ss2	Ss3			
V1	0.54	0.57	0.66			1.00	1.13	1.22			
V2	0.68	0.79	0.88			1.05	1.12	1.21			

ANOVA											
	F-Calculated					F-Calculated			F-Table		
									5%	1%	
Treatments	13.163**					9.204**			1.683	2.095	
Pu	0.374ns					0.99ns			2.743	4.085	
V	187.108**					8.049**			3.982	7.016	
Ss	40.027**					82.109**			3.153	4.938	
PuxV	2.751*					0.187ns			2.743	4.085	
PuxSs	1.503ns					0.790ns			2.232	3.074	
VxSs	7.832**					4.035*			3.153	4.938	
PuxVxSs	0.259ns					3.584*			2.232	3.074	
CV (%)	8.47					3.80					

Notes: - All the values are a mean of 4 replicates ; ns: not significant ; * : significant difference; ** : highly significant difference ;
- CV : Coefficient of variations

No differences were found for the treatment Pu either in St or G. This could be due to that the potential of the % N-to of St (average 0.66%) and G (average 1.13 %) have been reached in this work. The addition of urea in the form of tablets or prill with Azi and Azc had no influence whatever on the % N-to. For the difference between V1 and V2, reverse results were obtained. This reversed results showed that for St % N-to of V1 (0.59%) < V2 (0.75%), but for G % N-to of V1 (1.15%) **>** V2 (1.13%). This could be due that for V1, the N from straw was more efficient distributed to the grains (G) than that of V2, resulting in higher % N-to of V1 to that of V2 for G.

The % N-to of St and G, for the seasons, showed consistently increase from Ssl to Ss3, [St: Ssl (0.60% < Ss2 (0.68%) < Ss3 (0.73%)]; [G: Ssl (1.08%)< Ss2 (1.13%), Ss3 (1.21 %)]. It might be that this could be due to the increasing N in the soil with the progress of the seasons, resulting in increasing %N-to from season to season. For the interaction Pu x V x Ss only G showed significant difference. In crops where the end production is grain like lowland rice, all the nutrient absorbed including that of N will be piled up in the grain (G) resulting significant difference for Pu x V x S.

N-Total (N-to) Uptake

The perusal of the ANOV A in Table 3 showed that significant (*) and highly significant (**) was found for treatments: St (**), G (**), P1 (**); V: St (**), G (*), P1 (**) ; Ss: St (**), G (**), P1 (**); V x S : St (**), P1 (**). The rest of treatments single or interaction are not significant (ns).

For Pu as in % N-to, the uptake of N-to (kg N/ha) is not significant among Pu1 to P4. The explanation is in % N-to, where it might be that the N-soil is already high, so addition of urea in the form of tablets or prill combined with Azi and Azc were not responded by V1 or V2. As known the N-to uptake is the result of dry weight times % N- to. In Table 1 it is shown that there is no significant difference between V1 and V2 for dry weight, but significant differences was found for % N-to. Apparently % N-to has quite an influence on the N-to uptake by showing significant difference between V1 and V2 as was shown too by %N-to.

Like in %N-to for N-to uptake in St : V1 < V2, G: V1 **>** V2, P1: V1 < V2. For lowland rice or other seed crops, the most important end product is the grain production. In this work it is gained that for dry weight G : V1 > V2 (ns), for % N-to : V1 > V2 (**),for total N-uptake V1 **>** V2 (*), so although for other parameters (St and P1) where V1 **<** V2, but when it come to choosing which variety should be recommended then with great certainty V1 should be recommended. Data shown by Ss for N-to uptake showed results in line with % N-to for all the parameters observed (St, G, P1) there is a consistently increase from Ssl to Ss3. This could be explained as before for % N-to. Obviously the N-soil has been built up from S1 to S3. This made it possible for the crop to take up increasing N with the progress of

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seasons. It could be speculated that there could be an increase of SOM (Soil Organic Matter) with time and this is the main reason why there is an increase of N.

Percentage N-Derived From Fertilizer (% N-Pu) and N-Derived From Soil (%N-soil)

Data in Table 4 showed that, differences (*), highly differences (**) and non significant (ns) differences were found for:

- % N-PU : total treatments: St (**), G (**) ; Pu: St (**), G (**) ; Ss : St (**), G (**); Pu x V : St (**), G (ns) ; Pu x Ss : St (**), G (ns)
- % N-soil : total treatments: St (**), G (**) ; Pu: St (**), G (**) ; Ss : St (**), G (**); Pu x V : St (**), G (ns) ; Pu x Ss : St (**), G (ns)

For the rest of the treatments V x Ss and Pu x V x Ss no significant differences (ns) were found both for St and G. It was found for Pu (Table 1,2, 3) all the three parameters: dry weight (kg/ha), % N-to, and N-to uptake (kg N/ha), no difference were found for all of them. It could be assumed that for all the data presented in the previous tables the N faced by the lowland crop was a total of N: N-fertilizer **+** N-soil. Apparently the total-N available have the about same quantity, making the crops were able to take up N in equal amounts. This resulted in no significant differences were found for the parameters observed. While when looking at N-Pu and N-soil as separated N-sources as shown in Table 4, interesting facts occurred. Obviously the % N-Pu of urea in the form of tablets combined with Azi and Azc (Pul and Pu2) gave higher results than that of urea prill with Azi and Azc. This was true for St as well as G. For the % N-soil, the reverse of that of N-Pu was observed, which is when % N-Pu is high or low, then the % N-S would be the reverse. This data supported the data found previously in Tables 1, 2, 3 where no significant differences were found for N-Pu and N-soil, where low N-Pu will be covered by high N-soil and the reverse. The non significant difference of % N-Pu and % N-soil between V1 and V2 for St and G, showed that the varieties used gave equal responses to the N-sources (Pu1, Pu2, Pu3, Pu4).

Another interesting data for %N-Pu and % N-soil for Ss in St and G. It is shown that with the passing of seasons, the % N-Pu decreased significantly, on the other hand the % N-soil increased. This could be due to the built up of the N-soil especially the SOM as a source of N. For the interaction of Pu x V and Pu x S only for St the % N-Pu and % N-soil showed significant difference but not for G. It seems that an equal distribution was carried out from St to G, resulting in non significant differences in G for % N-Pu and % N-soil. More detail discussion will be forwarded for the next Tables which is N-uptake (kg N/ha).

Table 3. N-total uptake of straw, grain, and plants of lowland rice with several N-fertilizer levels at three consecutive seasons.

	Straw (St) – t/ha					Grain (Gt) – t/ha					Plants (Pt) – t/ha				
	N-Pu1	N-Pu2	N-Pu3	NPu4		N-Pu1	N-Pu2	N-Pu3	NPu4		N-Pu1	N-Pu2	N-Pu3	NPu4	
Ro-PuxVxSs															
V1 Ss1	18.94	18.98	21.20	21.24		62.01	62.17	58.80	62.38		81.00	81.14	80.00	82.62	
Ss2	26.66	24.27	23.30	25.26		79.85	70.56	74.64	69.15		106.51	94.82	98.17	94.41	
Ss3	35.32	33.35	33.31	30.74		72.77	78.20	67.38	76.73		108.09	111.55	99.36	107.41	
V2 Ss1	23.53	25.77	21.89	23.42		59.86	59.03	54.27	61.05		82.19	87.59	75.62	86.00	
Ss2	35.10	33.86	33.17	34.33		67.58	71.14	60.66	67.95		102.66	105.00	93.82	102.35	
Ss3	39.00	41.94	36.24	37.93		73.58	73.07	67.07	67.60		112.58	115.00	103.30	104.02	
Ro-Pu	29.76	29.69	28.18	28.82		69.27	69.03	63.80	67.48		98.84	99.18	91.71	96.13	
Ro-PuxV					Ro-V					Ro-V					Ro-V
V1	26.97	25.53	25.94	25.75	26.05	72.54	70.31	66.94	69.42	69.55	98.53	95.84	92.51	95.17	95.51
V2	32.54	33.85	30.43	37.89	32.18	67.01	67.75	60.67	65.53	65.24	99.14	102.58	90.91	97.46	97.51
Ro-PuxSs					Ro-Ss					Ro-Ss					Ro-Ss
Ss1	21.23	22.37	21.54	22.33	21.87	60.93	60.60	56.54	61.71	59.55	81.59	84.36	77.81	84.81	82.14
Ss2	30.88	29.06	28.23	29.79	29.49	73.72	70.85	67.865	68.55	70.19	104.59	99.91	96.00	98.38	99.72
Ss3	37.16	37.65	34.78	34.33	35.98	73.18	75.64	67.22	72.17	72.05	110.33	113.28	101.33	105.75	107.62
Ro-VxSs	Ss1	Ss2	Ss3			Ss1	Ss2	Ss3			Ss1	Ss2	Ss3		
V1	20.99	24.87	33.18			61.34	73.55	73.77			81.44	98.48	106.62		
V2	23.65	34.11	38.78			58.55	66.83	70.33			82.85	100.96	108.73		

ANOVA	F-Calculated		F-Calculated		F-Table 5%	F-Table 1%
Treatments	12.227**		2.711**		5.810**	1.685	2.095
Pu	0.865**		0.210**		2.944*	2.743	4.085
V	57.405**		6.460*		1.010**	3.982	7.016
Ss	101.500**		19.648**		57.015**	3.133	4.928
PuxV	0.991**		0.260**		0.772**	2.743	4.085
PuxSs	0.778**		0.352**		0.641**	2.232	3.074
VxSs	4.219*		0.512**		0.025**	3.133	4.928
PuxVxVxSs	0.478**		1.033**		0.579**	2.232	3.074
CV (%)	13.62		12.34		10.14		

Notes: - All the values are a mean of 4 replicates ; ns: not significant ; * : significant difference; ** : highly significant difference ;
CV : Coefficient of variations

Table 4. Percentage N-derived from fertilizer (% N-Pu) and percentage N-derived from soil (% N-S) of straw, grain, and plants of lowland rice with several N-fertilizer levels at three consecutive seasons.

| | Straw (St) | | | | | | | | Grain (G) | | | | | | | | |
| | Percentage N-derived from fertilizer (% N-Pu) | | | | Percentage N-derived from soilr (% N-S) | | | | Percentage N-derived from fertilizer (% N-Pu) | | | | Percentage N-derived from soilr (% N-S) | | | | |
	N-Pu1	N-Pu2	N-Pu3	N-Pu4	N-Pu1	N-Pu2	N-Pu3	N-Pu4	N-Pu1	N-Pu2	N-Pu3	N-Pu4	N-Pu1	N-Pu2	N-Pu3	N-Pu4	
Ro-PuxVxSs																	
V1 Ss1	17.25	22.80	10.91	24.02	82.75	77.20	89.09	75.98	21.18	21.13	17.86	18.92	78.83	78.88	82.40	81.10	
Ss2	17.55	15.45	3.71	7.80	82.48	84.55	96.29	91.97	18.14	16.89	5.95	7.21	81.86	83.14	94.05	92.79	
Ss3	7.65	8.68	4.46	6.74	92.40	91.33	95.29	93.26	9.68	10.49	4.89	5.81	90.32	89.52	95.11	94.19	
V2 Ss1	18.69	23.65	19.42	19.45	81.31	76.35	80.58	80.63	23.21	20.63	16.32	17.45	76.79	79.37	83.69	82.51	
Ss2	15.83	19.91	5.62	5.66	84.17	81.09	94.38	94.34	13.76	13.41	8.13	7.68	86.27	86.60	91.87	92.32	
Ss3	8.72	7.32	4.75	5.54	91.29	92.68	95.25	94.46	9.57	8.48	6.27	5.37	90.43	91.52	93.73	94.64	
Ro-Pu	14.28	16.13	8.14	11.53	85.73	83.86	91.81	88.44	15.92	15.17	9.90	10.41	84.08	85.90	90.14	89.60	
Ro-PuxV					Ro-V								Ro-V				Ro-V
V1	14.15	15.64	6.36	12.86	85.88	84.36	93.56	87.07	87.72	16.33	16.17	9.57	10.65	13.18	83.67	83.85	90.52	89.36	86.83
V2	14.41	16.65	9.93	10.22	85.59	83.37	90.07	89.81	89.81	15.51	14.17	10.24	10.57	12.52	84.50	85.90	89.76	89.84	87.48
Ro-PuxSs					Ro-Ss								Ro-Ss				Ro-Ss
Ss1	17.97	23.23	15.16	21.73	19.52	82.03	76.77	84.84	78.30	80.49	22.19	20.88	17.09	18.19	19.59	77.80	77.13	83.05	81.83	80.45
Ss2	16.69	17.18	4.67	6.72	11.32	83.32	82.82	95.34	93.16	88.46	15.95	15.15	7.04	7.45	7.45	84.07	84.97	92.96	92.56	88.61
Ss3	8.18	8.00	4.61	6.17	6.75	91.84	92.00	95.27	93.25	93.25	9.63	9.48	5.58	5.99	5.59	90.38	90.52	94.42	94.42	92.43
Ro-VxSs	Ss1	Ss2	Ss3		Ss1	Ss2	Ss3		Ss1	Ss2	Ss3		Ss1	Ss2	Ss3		
V1	18.75	11.13	6.88		81.96	88.82	93.07		19.77	12.05	7.72		80.30	82.96	92.29		
V2	20.30	11.51	6.58		79.72	88.50	93.42		19.40	10.74	7.42		80.60	89.32	92.58		

ANOVA				
	St % N-Pu	St % N-Soil	G % N-Pu	G % N-Soil
Treatments	23.238**	23.066**	17.369**	17.766**
Pu	35.635**	35.145**	28.955**	29.268**
V	0.877ns	0.750ns	1.265**	1.187**
Ss	163.819**	163.910**	148.032**	147.670**
PuxV	4.805**	4.831**	1.065**	0.942**
PuxSs	11.588**	11.078**	2.190**	2.165**
VxSs	2.095**	0.898**	0.310**	0.331**
PuxVxVxSs	1.832**	2.291**	1.256**	1.302**
CV (%)	22.79	3.26	22.21	3.27

Notes: - All the values are a mean of 4 replicates ; ns: not significant ; * : significant difference; ** : highly significant difference ;
- CV : Coefficient of variations

N-Uptake Derived From Fertilizer (N-Pu) and N-Uptake Derived From Soil (N-soil)

The data N-uptake derived from fertilizer (N-Pu) and N-uptake from soil (N-soil) are presented in Tables 5, 6 and 7. As for %N-Pu and %N-soil the N Pu uptake for St, G, P1 (Table 5) are far below N-soil (Table 6) for the same parameters. This could be due to that the N-soil available exceeded the N-Pu so the plants could use more N-soil compared to that of N-Pu. From Table 5, it is shown that significant differences were found for N-Pu in St, G, and P1. Here again it shown that the form of urea as tablets added with Azi and Azc (Pu1 and Pu2) are above that of urea as prill combined with Azi and Azc. As the form of urea as tablets is assumed to be more effective than prill due to its placement and release. The urea in form of tablets has to be put about 5 cm under the soil surface while when in the form prill the urea is put at the surface, so more open to volatilization and surface flow compare to that of urea in the form of tablets. This is supposed why N-Pu uptake of Pu1 and Pu2 are higher than that of Pu3, Pu4 for St, G and P1.

Table 5. N-Pu and N-soil uptake of straw of lowland rice applied with several levels of N-fertilizers at three consecutive seasons.

	N-Pu uptake (kg N/ha)					N-soil uptake (kg N/ha)				
	N-Pu1	N-Pu2	N-Pu3	NPu4		N-Pu1	N-Pu2	N-Pu3	NPu4	
Ro-PuxVxSs										
V1 Ss1	3.22	4.32	2.47	5.05		15.73	14.67	18.73	15.95	
Ss2	4.79	3.77	0.87	1.97		21.99	20.50	22.43	23.23	
Ss3	2.69	2.88	1.50	2.10		32.63	30.47	31.74	28.64	
V2 Ss1	4.35	6.00	4.24	4.49		19.18	19.77	17.64	18.89	
Ss2	5.59	6.43	1.86	1.93		29.51	25.38	31.31	31.65	
Ss3	3.42	3.08	1.72	2.15		35.58	38.87	34.50	35.82	
Ro-Pu	4.00	4.41	2.11	2.95		25.77	24.94	26.06	25.70	
Ro-PuxV					Ro-V					Ro-V
V1	3.55	3.65	1.61	2.96	2.96	23.45	21.88	24.30	22.61	23.06
V2	4.45	5.17	2.61	3.77	3.77	28.09	28.01	27.81	28.79	28.17
Ro-PuxSs					R-o-Ss					Ro-Ss
Ss1	3.78	5.16	3.36	4.77	4.27	17.46	17.22	18.18	17.42	17.57
Ss2	5.17	5.11	1.37	1.95	3.40	25.75	22.94	21.87	27.44	25.75
Ss3	3.05	2.98	1.61	2.13	2.44	34.10	34.67	33.12	32.23	33.53
Ro-VxSs	Ss1	Ss2	Ss3			Ss1	Ss2	Ss3		
V1	3.76	2.84	2.29			16.27	22.04	30.87		
V2	4.76	3.96	2.59			18.87	29.46	36.0		
ANOVA.										
		F-Calculated				F-Calculated			F-Table	
									5%	1%
Treatments		10.830**				17.653**			1.685	2.095
Pu		30.251**				0.437ns			2.743	4.085
V		18.189**				90.535**			3.982	7.006
Ss		31.039**				164.120**			3.133	4.928
PuxV		3.360**				0.793ns			2.743	4.085
PuxSs		18.873**				1.502ns			2.232	3.074
VxSs		1.829ns				3.773**			3.133	4.928
PuxVxSs		1.419ns				1.088ns			2.232	3.074
CV (%)		27.53				13.78				

Notes: - All the values are a mean of 4 replicates ; ns: not significant ; * : significant difference; ** : highly significant difference ;
- CV : Coefficient of variations

Table 6. N-Pu and N-soil uptake of grain of lowland rice applied with several levels of N-fertilizers at three consecutive seasons.

		N-Pu uptake (kg N/ha)					N-soil uptake (kg N/ha)				
		N-Pu1	N-Pu2	N-Pu3	NPu4		N-Pa1	N-Pa2	N-Pa3	NPa4	
Ro-PuxVxSs											
V1	Ss1	13.28	13.15	10.48	11.51		48.78	49.02	48.55	50.90	
	Ss2	14.57	11.99	4.66	5.00		65.41	58.62	69.98	64.15	
	Ss3	7.06	8.23	3.26	4.44		65.71	69.91	64.12	72.28	
V2	Ss1	13.41	12.15	8.87	10.62		46.52	46.83	45.40	53.43	
	Ss2	9.44	9.49	4.87	5.24		58.06	61.70	55.79	62.71	
	Ss3	7.08	6.18	4.71	3.62		66.58	66.89	62.89	63.98	
Ro-Pu		10.79	10.18	6.05	6.74		58.52	58.83	57.78	60.74	
Ra-PuxV						Rx-V					Ra-V
V1		11.64	11.11	6.12	6.98	8.96	55.95	59.18	60.88	62.44	68.61
V2		9.95	9.26	5.98	6.49	7.92	57.89	58.48	54.68	59.04	57.32
Ro-PuxSs						R-o-Ss					Ro-Ss
Ss1		13.35	12.65	9.66	11.11	11.68	47.63	47.93	46.98	50.66	48.30
Ss2		12.00	10.70	4.77	5.12	8.15	61.79	60.16	62.88	63.43	62.06
Ss3		7.04	7.20	3.74	4.03	5.50	66.14	68.40	63.49	68.13	66.54
Ro-VxSs		Ss1	Ss2	Ss3			Ss1	Ss2	Ss3		
V1		12.10	9.05	5.75			49.30	64.54	68.00		
V2		11.26	7.25	5.25			47.30	59.99	65.08		

ANOVA					
	F-Calculated		F-Calculated	F-Table	
				5%	1%
Treatments	12.434**		5.041**	1.685	2.095
Pu	33.133**		0.655**	2.743	4.083
V	6.284**		4.470*	3.982	7.016
Ss	74.143**		49.659**	3.133	4.928
PuxV	1.059ns		0.020ns	2.743	4.083
PuxSs	2.941*		0.190ns	2.232	3.074
VxSs	0.877ns		0.312ns	3.133	4.928
PuxVxSs	1.559ns		0.980ns	2.232	3.074
CV (%)	24.13		10.97		

Notes: - All the values are a mean of 4 replicates ; ns: not significant ; * : significant difference ; ** : highly significant difference ;
- CV : Coefficient of variations

Table 7. N-Pu and N-soil uptake of plants (straw + grain) of lowland rice applied with several levels of N-fertilizers at three consecutive seasons.

	N-Pu uptake (kg N/ha)					N-soil uptake (kg N/ha)				
	N-Pu1	N-Pu2	N-Pu3	NPu4		N-Pu1	N-Pu2	N-Pu3	NPu4	
Ro-PuxVxSs										
V1 Ss1	16.47	17.47	12.92	16.56		64.46	63.69	67.28	66.85	
Ss2	18.09	16.51	5.42	7.38		87.40	79.12	92.41	87.38	
Ss3	9.02	9.94	4.80	6.10		98.34	100.38	95.86	100.93	
V2 Ss1	21.97	21.60	17.21	18.02		7.06	64.64	64.66	69.29	
Ss2	14.35	15.21	7.27	7.07		87.67	87.88	86.84	93.36	
Ss3	9.25	8.03	6.09	5.55		102.15	105.76	97.36	99.8	
Ro-Pu	14.86	14.79	8.93	10.11		85.18	83.44	84.07	86.56	
Ro-PuxV					Ro-V					Ro-V
V1	14.53	14.64	7.71	10.00	11.72	83.40	81.06	85.15	85.05	83.67
V2	15.19	14.94	10.19	10.21	12.63	86.96	85.83	82.95	88.07	85.93
Ro-PuxSs					R-o-Ss					Ro-Ss
Ss1	19.22	19.53	11.04	17.29	17.78	62.76	64.14	65.97	68.07	66.49
Ss2	16.23	10.57	6.34	7.73	11.41	87.45	83.10	89.62	91.24	87.88
Ss3	9.14	5.59	5.45	5.82	7.35	100.24	103.07	96.61	100.36	100.07
Ro-VxSs	Ss1	Ss2	Ss3			Ss1	Ss2	Ss3		
V1	15.85	11.85	7.46			65.57	86.58	98.87		
V2	19.70	10.97	7.23			67.41	89.18	101.27		
ANOVA										
		F-Calculated					F-Calculated		F-Table	
									5%	1%
Treatments		23.437**					10.280**		1.685	2.096
N-Pu		43.570**					0.542ns		2.743	4.083
V		3.777*					1.900ns		3.982	7.016
Ss		167.884**					111.573**		3.133	4.928
N-PuxV		1.284ns					0.692ns		2.743	4.083
N-PuxSs		6.221**					0.826ns		2.232	3.074
VxSs		9.964**					0.013ns		3.133	4.928
PuxVxVxSs		1.274ns					0.518ns		2.232	3.074
CV (%)		18.85					10.73			

Notes: - All the values are a mean of 4 replicates ; ns: not significant ; * : significant difference; ** : highly significant difference ;
- CV : Coefficient of variations

Differences were found between V1 and V2, for St (**), G (**), P1 (*). N-Pu for St: Vl< V2, G: Vl>V2, P1: Vl<V2. Obviously in St V2 could distributed less N-Pu to the grains (G), resulting in higher N-Pu of V1 than V2. While for P1 due to its accumulation of St + G. Apparently the N-Pu of St in V2 influence more the N-Pu of P1 compared to that of V1. The most important part is G for lowland rice, so with V1 having more N-Pu than V2, then this will be an important issue to choose V1 above V2 besides its dry weight to be planted in the field. This also showed that V1 is superior to V2 in efficiently distributed N-Pu from St to G. Contrary to the N-to uptake, the N-Pu uptake decrease with the passing of seasons (Table 4), where Ss1>Ss2>Ss3 for St, G, P1. This meant that that the constituent of the N-to which is N-soil + N-Pu increase, it reaches the highest level by the increase of N-soil as will be shown in the increase of N-soil uptake which be discussed in the N-soil uptake. The interaction between Pu x V only shows G where N-Pu V1 >N-Pu V2, while for St and P1 the reverse occurred. As mentioned before for lowland rice, the most important product is grain

(G). So that the highest dry weight, the highest N uptake whether from Pu or soil is the reason to be taken into consideration to choose V1 above V2. Interaction between Pu x Ss with the progress of seasons showed that the N-Pu is decreasing. An other important observation as in Pu x V, here for Pu x Ss too the form of urea in tablets is superior to that of prill, added with Azi or Azc. This is all true for St, G and P1. The important interaction data of Pu x V x S are that with the passing of seasons (Ss) the N-Pu decreased for V1 and V2, and for V1 and V2 the N-Pu in form of tablets is superior to N-Pu in form of prill.

For the treatments for St, G, P1 showed all highly significant difference in N-soil uptake. Breaking the treatments to single and interaction treatments show data as will be forwarded next. No significant difference was shown by application of Pu on N-soil uptake (Pu^{ns}). But highly significant difference for V and Ss. For V, again as in N-Pu uptake, here it shown again that for G the N-soil uptake for G V1 > V2 and for both St and Pu the reverse occurred. Contrary to N-Pu, with progress of time (Ss) the N-soil increased. This meant that N-soil with the passing of seasons (Ss), accumulated to high amounts and this N-soil provided the largest N part uptake of St, G, P1. Could this be a sign that the SOM has accumulated and this would be a reason on the increase of soil quality from the view point of N. Due to these data it is correct to say that for good end production of lowland rice which is grain the main role is done by N-soil. This need more investigation.

For the interaction of Pu x V, Pu x Ss, V x Ss and Pux V x Ss no significant differences were found, except for V x Ss only for St. As has been mentioned before this obviously due to the distribution of N from St to G, where for V2 the distribution from St to G was less than that of Vl.

The most important about N-soil uptake is that the addition of N-Pu combined with Azi and Azc whether in the form of tablets or prills has no influence on N-soil uptake. Further with the passing of seasons showed N-soil accumulated while for N-Pu it decreased significantly. This is valid for St, G, P1.

CONCLUSIONS

From this work apparently N-Pu play a less important role in growth of lowland crop expressed in several parameters compared to N-soil. The form of N-urea in tablets are superior to that the form of urea in prills.

For the last product of lowland rice which is grain obviously V1 (Atomita-1) is better than V2 (IR-64) expressed in t/ha.

The progress of seasons showed clearly that there is an N accumulation which might be the increase of soil organic matter (SOM) and that means there is an increase in soil quality in the view point of N.

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