

Different Rates of N:P:K Fertilizer Effect on the Growth, Yield and Productivity of Component Crops in Upland Rice-Soybean Intercropping System

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Abstract. A two-year field experiment was carried out in the 2018 and 2019 cropping seasons to assess the effect of different rates of N:P:K (15:15:15) fertiliser on the growth, yield and productivity of component crops in upland rice-soybean intercrop in lowland humid region of Umudike, southeast Nigeria. The experiment was laid out in randomised complete block design (RCBD) with three replications. However, cropping system fertiliser rates were considered fixed during the statistical analysis to elicit more information on the effect of the cropping system in the study. The treatments include intercrop rice-soybean with five levels of N:P:K 15:15:15 at 0, 100, 200, 300 and 400 kg/ha fertiliser rates and sole upland rice and sole soybean each at the same rate. The results showed that the interaction of upland rice and soybean with N:P:K fertiliser significantly affected the plant height, number of leaves, leaf area index, weight of seeds per panicle, weight of seeds per plant and 1000 - seeds weight of upland rice. Based on the result of this investigation, it was observed that the cropping system and increased fertiliser rates positively affected the growth and yield component of upland rice and soybean. It was noted that the N:P:K fertiliser rate (400 kg) gave the highest growth and yield component of upland rice in the rice/soybean intercropping system. LER, as shown from the result, indicated that intercropped upland rice with 400 kg/ha N.P.K was highest in 2018, although the trend was not the same in 2019 as the gross monetary return.

Keywords: *Oryza sativa*; *Glycine max*; performance; yield; productivity.

INTRODUCTION

Intercropping is growing two or more crops on the same land within the same year to promote their interaction and maximise productivity by avoiding dependence on only one crop [1]. Mixed cropping or intercropping expresses farmers' desire to minimise risk. The yield advantage of intercropping has not been so marked in several situations, possibly due to the use of either super-optimal or sub-optimal plant population proportion for component crops. Upland rice (*Oryza sativa*) is a staple food crop for millions in Asia and Africa [2]. It is typically grown in rainfed and upland areas, where the soil is often poor in nutrients and prone to erosion. Upland rice has been found to have allelopathic effects on other

crops, which can be both positive and negative. Some studies have reported that intercropping upland rice with legumes like cowpea and soybean can improve soil fertility and increase the yield of both crops [3]. However, other studies have shown that intercropping with upland rice can also negatively affect the growth and yield of other crops, such as maize and groundnut [4].

Soybean (*Glycine max*) is known for its high protein content and oil production. It is widely grown in the Americas, Asia, and Africa [2]. Soybeans face low soil fertility and pest and disease pressure like mung beans. Intercropping soybeans with upland rice can improve soybean yields and reduce pest and disease pressure through the allelopathic effect of rice [2]. Soybean

is an important leguminous crop widely grown in many parts of the world, including Asia, North America, and South America. It is a rich source of protein and oil, making it a valuable crop for human and animal consumption. Soybeans are often intercropped with maize, rice, and other crops to increase productivity. The study assessed the effect of N.P.K fertiliser rates on upland rice and soybean growth, yield and productivity in an intercropping system.

METHODS

This experiment was conducted during the 2018 and 2019 cropping seasons on the research farm of Michael Okpara University of Agriculture, Umudike, located around longitude 07° 33'E and latitude 05° 29' N at an elevation of 122m above sea level in the humid tropical lowland of southeast Nigeria. The treatments were five rates of N:P:K-15:15:15 fertiliser viz: (0 kg/ha, 100 kg/ha, 200 kg/ha, 300 kg/ha, and 400 kg/ha) which were applied to sole and intercropped upland rice (FARO 58) and soybean (TG_x 47). The experiment was laid out in a randomised complete block design (RCBD) with three replications. Each experimental plot measured 2×2m (4m²) with an intra-block spacing of 0.5 m and inter-block spacing of 1m.

The treatments were:

- Sole Upland rice + 0 kg/ha of N:P:K,
 - Sole upland rice + 100 kg/ha of N:P:K,
 - Sole Upland rice + 200 kg/ha of N:P:K,
 - Sole upland rice + 300 kg/ha of N:P:K,
 - Sole Upland rice + 400 kg/ha of N:P:K,
 - Sole Soybean + 0 kg/ha of N:P:K,
 - Sole Soybean + 100 kg/ha of N:P:K,
 - Sole Soybean + 200 kg/ha of N:P:K,
 - Sole Soybean + 300 kg/ha of N:P:K,
 - Sole Soybean + 400 kg/ha of N:P:K,
 - Upland rice + Soybean + 0 kg/ha of N:P:K,
 - Upland rice + Soybean + 100 kg/ha of N:P:K,
 - Upland rice + Soybean + 200 kg/ha of N:P:K,
 - Upland rice + Soybean + 300 kg of N:P:K
 - Upland rice + Soybean + 400 kg of N:P:K.
- The N.P.K fertiliser treatments were applied using the ring application method on each plant. Insect

pest was controlled at 2 and 4 WAP using *Lambdacyhalothrin* 2.5 EC at 300mL/ha.

Soil samples were collected randomly at 0-20 cm from different representation locations of the experimental site with a soil auger and taken to the laboratory to determine the physical and chemical properties. Bouyoucos method was used to determine the % of sand, silt, and clay [5]. Using pH meter, authors [6] was used to determine soil pH in a 1:2.5 soil/water ratio. Organic matter content was obtained by multiplying total carbon by 1.724. Organic carbon content was determined by the Walkey-Black method [7]. Total nitrogen was used to determine by the microkjeldahl method [8]. The bray-1 method [9] was used to determine available phosphorus. Exchangeable cations (Ca, Mg, K and Na) were extracted with one standard neutral ammonium acetate solution according to [10], and exchangeable K and Na were read using a flame photometer.

In contrast, Ca and Mg were read using an atomic absorption spectrophotometer. The growth and yield parameters measured for upland rice include plant height, number of leaves per plant, leaf area index, number of tillers per plant and yield parameters include weight of seeds per panicle, weight of seeds per plant, 1000-seed weight and grain yield. Data collected for soybeans include Plant height per plant, number of leaves per plant, Leaf area index, number of branches per plant, number of seeds per pod, number of seeds per plant, weight of seeds per plant and grain yield.

The growth and yield data collected were subjected to analysis of variance (ANOVA) using [11], where the cropping system and fertiliser rate were fixed factors. According to [12], treatment means were compared for statistical significance using Fisher's least significant difference (F-LSD) at a 0.05 probability level [12]. The Land Equivalent Ratio (LER) was used to determine intercropping advantages. The LER was calculated using $LER = \sum(Y_{pi}/Y_{mi})$. Y_p is the yield of each crop in the intercrop or polyculture, and Y_m is each crop in the sole or monoculture. Gross monetary return (GMR) (₦ ha⁻¹) was calculated for upland rice (*Oryzae sativa* L.) and soybean treatment plots based on the prevailing local market price per hectare of the farm produce. The gross monetary return gives the actual financial return the farmer received from the produce.

RESULTS AND DISCUSSION

The soils of the experimental sites were texturally sandy loam in 2018 and 2019 (Table 1). The soil indicated low pH, with a value of 4.5 in 2018 and 5.13 in 2019. Soil organic matter and nitrogen were high in both years, but their values in 2018 were higher than in 2019. Available P was high in both years but higher in 2018 than in 2019. Soil calcium and magnesium were above the critical levels, but potassium was below them. The base saturation of the soil was also high in both years: rice growth and yield. The cropping system showed a significant difference ($p < 0.05$) in the vegetative parameters of upland rice in both cropping seasons except for the number of leaves per plant in 2018 and plant height in 2019, while a significant difference was recorded in the weight of panicles/plant, weight of seeds/plant in 2018 and grain yield in 2019 (Table 2 and 3). This could be due to the low nutrient uptake from resource competition between the legume crops and rice plants. This is also in alignment with [13], who reported that intercropping significantly reduced the height of rice. However, among the significant parameters, intercrop upland rice gave the highest values for the vegetative and growth parameters in 2018, but the trend was not the same in 2019. N:P:K fertiliser showed significant differences in all upland rice's vegetative and growth parameters in both cropping seasons except for plant height and number of leaves in 2018.

Among the vegetative and growth parameters, upland rice/soybean that received 400 kg gave the highest values in both cropping seasons, except for seed/panicle, 1000-seed weight, and grain yield in 2019. The interactive treatments showed significant differences across the growth and yield parameters in 2018 and 2019, with the expected plant height and weight of seed/panicle in 2019. Among the significant interactive parameters, sole rice that received 400 kg/ha N:P:K had the highest growth and yield parameters in 2019. This result is consistent with

the findings of [14, 15, 16], who reported that intercrop rice with legumes significantly increased the yield components of rice in the rice/soybean system. Among the treatments, the application of 400 kg/ha N:P:K gave the highest number of tillers/branches per rice-soybean plant in both cropping seasons. The finding was consistent with [17, 18, 19], who reported that the number of tillers/branches per plant of the component crops in rice/soybean intercrop was increased with an increase in fertiliser rate application. This implies that the increase in nitrogen application could considerably improve the number of tillers/branches in rice or soybeans. This result was in consonant with [20, 21, 22], who reported that a significant increase in growth parameters of soybean was achieved with an increase in N:P:K fertiliser application. At the same time, a decrease was recorded under rice due to zero fertiliser application [23, 24].

The interaction between the cropping system and NPK fertiliser rates showed significance in all the measured parameters in both cropping seasons except for grain yield in 2018 and the number of branches/plants in 2019. Among the interactive treatments, sole soybean band intercrop soybeans receiving 400 kg N:P:K fertiliser gave the highest growth and yield parameters value in 2018 and 2019, respectively. The total LER values obtained were above 1.0 in all treatment combinations regardless of the crop combination and fertiliser rates, indicating yield advantage due to intercropping. The highest LER, 1.69 and 1.61, were obtained from rice + soybean + 300 kg/ha in 2018 and rice+soybean + 0 kg/ha N:P:K in 2019. The lowest LER values were obtained from rice + soybean + 100 kg/ha N:P:K in 2018, although the trend was not the same in 2019. Authors [24] in maize/cowpea recorded a higher total LER in the mixture. Gross monetary returns were highest for rice/soybean, which received 400kg/ha N:P:K. This implies that it could be obtained from the intercrop component crops under increased N:P:K availability.

Table 1 – Physico-chemical properties of the experimental sites in the 2018 and 2019 cropping seasons

Parameters	2018	2019
Physical properties		
Sand (%)	64.7	81.20
Silt (%)	11.4	9.70
Clay (%)	12.9	11.10
Chemical properties		
pH (H ₂ O)	4.5	5.13

Parameters	2018	2019
Organic matter (%)	2.42	1.71
Organic carbon (%)	1.13	1.07
Total N (%)	0.23	0.17
Available P (mg Kg ⁻¹)	19.8	13.78
Exchangeable K (cmol kg ⁻¹)	0.17	0.24
Exchangeable Na (cmol kg ⁻¹)	0.23	0.12
Exchangeable Ca (cmol kg ⁻¹)	7.4	3.20
Exchangeable Ea (cmol kg ⁻¹)	0.48	1.49
Exchangeable Mg (cmol kg ⁻¹)	1.0	1.08
Effective CEC (cmol kg ⁻¹)	9.14	4.76
Base saturation (%)	94.68	81.53

Table 2 – Effect of cropping system, fertiliser rate and their interactions on growth and yield of upland rice in upland rice/soybean intercropping system (Treatment 2018)

	PH (cm) NL LAI NTP 8WAP				WSP WS 1000-SW, g			GY, t/ha
Cropping system (C)								
Sole rice	16.73	35.60	1.771	11.80	1.87	11.05	18.30	1.217
Intercrop rice	18.63	36.90	2.238	8.55	2.10	12.62	18.77	1.365
LSD _(0.05)	1.407	Ns	0.333	1.104	0.196	0.784	ns	ns
NPK-15:15:15 Fertilizer rate (F), kg ha⁻¹								
0 (Control)	16.20	31.00	1.248	7.97	1.61	6.40	16.26	0.77
100	18.25	33.00	1.337	9.86	1.62	9.13	17.77	1.10
200	18.03	39.50	2.270	10.65	1.74	10.50	16.41	1.07
300	18.22	38.70	2.703	10.50	2.36	15.57	20.03	1.35
400	17.70	39.01	2.463	11.90	2.59	17.58	22.19	2.16
LSD _(0.05)	ns	Ns	0.527	1.745	0.310	1.240	1.992	0.568
Interaction (C × F)								
Sole rice × 0kg ha ⁻¹	16.30	35.00	1.368	7.63	1.63	6.19	16.67	0.90
Sole rice × 100kg ha ⁻¹	18.17	33.10	1.217	11.25	1.54	9.22	17.96	1.24
Sole rice × 200 kg ha ⁻¹	15.38	34.90	1.674	13.64	1.74	9.46	16.96	0.99
Sole rice × 300 kg ha ⁻¹	15.77	34.60	2.039	12.33	3.02	15.14	24.11	2.69
Sole rice × 400 kg ha ⁻¹	18.03	40.70	2.557	14.13	2.16	15.24	20.27	1.63
Intercrop rice × 0 kg ha ⁻¹	16.10	27.00	1.129	8.30	1.59	6.61	15.85	0.64
Intercrop rice × 100 kg ha ⁻¹	18.33	32.90	1.457	8.47	1.71	9.04	17.58	0.97
Intercrop rice × 200 kg ha ⁻¹	20.67	44.20	2.865	7.67	1.75	11.54	15.86	1.22
Intercrop rice × 300 kg ha ⁻¹	20.67	42.90	3.368	8.67	2.46	15.99	20.42	1.31
Intercrop rice × 400 kg ha ⁻¹	17.37	37.60	2.370	9.67	2.26	19.92	19.64	1.40
LSD _(0.05)	3.147	12.560	0.745	2.488	0.438	1.754	2.817	0.803

Notes: PH – Plant height, NL – number of leaves/plant, LAI – Leaf area index, NTP – number of / plant, WSP – weight of seeds/ panicle, WS – weight of seeds/plant, 1000-SW – 1000-seed weight; GY – grain yield.

Table 3 – Effect of cropping system, fertiliser rates and their interaction on the growth and yield of upland rice in upland rice /soybean intercropping system (Treatment 2019)

	PH(cm) NL LAI NTP 8WAP				WS P WS 1000-SW, g			GY, t/ha
Cropping system (C)								
Sole rice	23.54	40.60	0.806	11.80	3.40	28.0	25.09	2.54
Intercrop rice	22.14	30.80	1.680	8.55	3.17	29.8	26.26	1.60
LSD _(0.05)	ns	6.530	0.271	1.104	ns	ns	ns	0.731
NPK-15:15:15 Fertilizer rate (F), kg ha⁻¹								
0 (Control)	19.45	29.30	1.206	7.97	2.41	13.10	20.85	1.38
100	21.00	32.70	1.382	9.86	3.10	28.50	23.34	1.95
200	21.08	33.70	1.729	10.65	3.57	24.90	27.75	1.89
300	23.34	39.70	2.258	10.50	3.73	37.90	30.43	2.90

	PH(cm)	NL	LAI	NTP	8WAP	WS	P	WS	1000-SW, g	GY, t/ha
400	26.82	43.00	2.415	11.90	3.62	40.30	26.02	2.22		
LSD _(0.05)	5.500	10.320	0.428	1.745	0.721	13.15	3.789	1.155		
Interaction (C × F)										
Sole rice × 0 kg ha ⁻¹	19.60	27.60	1.112	7.63	2.77	14.5	20.74	1.47		
Sole rice × 100 kg ha ⁻¹	21.73	35.50	1.371	11.25	3.03	20.9	21.46	2.09		
Sole rice × 200 kg ha ⁻¹	22.50	43.10	2.000	13.64	3.70	26.2	27.50	2.61		
Sole rice × 300 kg ha ⁻¹	25.20	44.90	2.416	12.33	3.84	36.4	30.94	3.64		
Sole rice × 400 kg ha ⁻¹	28.65	51.70	2.682	14.13	3.65	42.3	25.85	2.88		
Intercrop rice × 0 kg ha ⁻¹	19.29	31.00	1.300	8.30	2.05	11.6	20.96	1.28		
Intercrop rice × 100 kg ha ⁻¹	20.27	29.90	1.393	8.47	3.17	36.2	25.22	1.81		
Intercrop rice × 200 kg ha ⁻¹	19.66	24.20	1.459	7.67	3.30	23.6	28.00	1.17		
Intercrop rice × 300 kg ha ⁻¹	21.47	34.60	2.100	8.67	3.76	39.5	19.64	2.17		
Intercrop rice × 400 kg ha ⁻¹	25.00	34.20	2.148	9.67	3.58	38.3	26.19	1.56		
LSD _(0.05)	ns	14.600	0.605	2.488	ns	18.68	5.350	1.634		

Notes: PH – Plant height, NL – number of leaves/plant, LAI – Leaf area index, NTP – number of / plant, WSP – weight of seeds/ panicle, WS – weight of seeds/plant, 1000-SW – 1000-seed weight; GY – grain yield.

Table 4 – Effect of cropping system, fertiliser rate and their interactions on growth and yield of soybean in upland rice /soybean intercropping system (Treatment 2018)

	PH (cm)	NL	LAI	NBP	8WAP	NSP	NS	WPP, g	GY, t/ha	
Cropping system (C)										
Sole soybean	37.6	37.57	3.99	37.57	1.94	134.10	13.65	3.44		
Intercrop soybean	34.8	35.14	3.46	35.14	2.12	159.80	16.58	2.65		
LSD _(0.05)	ns	ns	ns	ns	ns	8.090	1.958	0.763		
NPK-15:15:15 Fertilizer rate (F) (kg ha⁻¹)										
0 (Control)	32.20	32.15	3.14	32.15	1.69	120.00	7.18	2.48		
100	36.60	36.65	3.88	36.65	1.99	136.70	11.55	3.00		
200	35.10	35.50	2.93	35.50	2.14	152.00	14.62	3.36		
300	32.50	34.55	3.74	34.55	2.21	157.90	19.72	3.08		
400	42.10	42.90	4.95	42.90	2.13	168.20	22.49	3.30		
LSD _(0.05)	6.970	6.348	1.047	6.348	0.337	12.790	3.097	ns		
Interaction (C × F)										
Sole soybean × 0 kg ha ⁻¹	30.70	30.70	3.50	30.70	1.47	110.40	7.26	2.76		
Sole soybean × 100 kg ha ⁻¹	40.40	40.40	4.22	40.40	1.86	120.50	10.56	3.59		
Sole soybean × 200 kg ha ⁻¹	36.20	35.87	2.85	35.87	2.04	139.10	12.77	3.87		
Sole soybean × 300 kg ha ⁻¹	36.40	36.37	4.37	36.87	2.26	145.50	17.23	3.49		
Sole soybean × 400 kg ha ⁻¹	44.50	44.50	5.03	44.50	2.09	155.30	20.42	3.48		
Intercrop soybean × 0 kg ha ⁻¹	33.60	33.61	2.79	33.61	1.91	129.70	7.10	2.19		
Intercrop soybean × 100 kg ha ⁻¹	32.90	32.90	3.54	32.90	2.12	152.80	12.55	2.42		
Intercrop soybean × 200 kg ha ⁻¹	35.10	35.13	3.02	35.13	2.25	165.00	16.48	2.85		
Intercrop soybean × 300 kg ha ⁻¹	32.70	32.73	3.10	32.73	2.16	170.40	22.22	2.68		
Intercrop soybean × 400 kg ha ⁻¹	39.70	41.31	4.87	41.31	2.18	181.00	24.56	3.13		
LSD _(0.05)	2.100	8.977	1.481	8.977	0.477	18.090	4.379	ns		

Notes: PH – Plant height; NL – number of leaves/plant; LAI – Leaf area index; NBP – number of branches/plant; NSP – number of seeds/pod; NS – number of seeds/plant; WPP – weight of seeds/plant; GY – grain yield.

Table 5 – Effect of cropping system, fertiliser rates and their interaction on the growth and yield of soybean in upland rice /soybean intercropping system (Treatment 2019)

	PH (cm)	NL	LAI	NBP	8WAP	NSP	NS	WPP, g	GY, t/ha
Cropping system (C)									
Sole soybean	44.28	29.70	5.27	5.08	1.83	130.50	14.88	3.29	
Intercrop soybean	44.22	32.10	5.03	4.53	2.09	139.00	14.62	2.32	
LSD _(0.05)	ns	ns	ns	ns	0.205	8.310	ns	0.759	
NPK-15:15:15 Fertilizer rate (F), kg ha⁻¹									
0 (Control)	39.93	28.30	4.14	4.72	1.74	95.90	7.66	1.89	
100	42.69	25.70	4.86	4.50	1.92	126.50	10.87	2.85	
200	39.67	28.80	4.90	4.42	2.04	145.40	13.47	3.12	
300	47.75	35.70	5.87	4.72	1.90	135.40	18.87	2.77	
400	51.20	36.10	6.00	5.67	2.20	170.50	22.89	3.39	
LSD _(0.05)	6.547	8.230	1.087	ns	0.325	13.130	1.600	1.201	
Interaction (C × F)									
Sole soybean × 0 kg ha ⁻¹	42.30	28.8	4.32	5.17	1.55	91.10	7.63	2.17	
Sole soybean × 100 kg ha ⁻¹	41.73	25.0	4.86	4.83	1.60	115.80	11.23	3.42	
Sole soybean × 200 kg ha ⁻¹	38.50	27.9	4.92	4.50	1.92	135.90	14.42	3.76	
Sole soybean × 300 kg ha ⁻¹	45.70	33.80	5.91	5.27	1.89	143.40	19.31	3.27	
Sole soybean × 400 kg ha ⁻¹	53.17	33.00	6.36	5.63	2.21	166.20	22.11	3.82	
Intercrop soybean × 0 kg ha ⁻¹	37.57	27.70	3.96	4.27	1.92	100.70	7.70	1.61	
Intercrop soybean × 100 kg ha ⁻¹	43.65	26.30	4.86	4.17	2.24	137.20	10.51	2.27	
Intercrop soybean × 200 kg ha ⁻¹	40.83	29.70	4.88	4.33	2.16	154.80	12.81	2.48	
Intercrop soybean × 300 kg ha ⁻¹	49.80	37.70	5.82	4.17	1.91	127.30	18.43	2.28	
Intercrop soybean × 400 kg ha ⁻¹	49.23	39.20	5.64	5.70	2.20	170.50	23.67	2.96	
LSD _(0.05)	9.259	11.63	1.537	ns	0.459	18.570	2.630	1.698	

Notes: PH – Plant height; NL – number of leaves/plant; LAI – Leaf area index; NBP – number of branches/plant; NSP – number of seeds/pod; NS – number of seeds/plant; WPP – weight of seeds/plant; GY – grain yield.

Table 6 – Effect of cropping system and fertiliser rate on land equivalent ratio and gross monetary return on upland rice and soybean intercrop in 2018 and 2019 cropping seasons

Table beginning

	Land equivalent ratio (LER)			Gross monetary return (N:K)		
	Partial		Total	2019 Rice Soybean Total		
	Rice	Soybean				
Sole rice + 0 kg/ha N:P:K	1.00	-	1.00	808500	-	808500
Sole rice + 100 kg/ha N:P:K	1.00	-	1.00	1149500	-	1149500
Sole rice + 200 kg/ha N:P:K	1.00	-	1.00	1435500	-	1435500
Sole rice + 300 kg/ha N:P:K	1.00	-	1.00	2002000	-	2002000
Sole rice + 400 kg/ha N:P:K	1.00	-	1.00	1584000	-	1584000
Sole soybean + 0 kg/ha N:P:K	-	1.00	1.00	-	759500	759500
Sole soybean + 100 kg/ha N:P:K	-	1.00	1.00	-	1197000	1197000
Sole soybean + 200 kg/ha N:P:K	-	1.00	1.00	-	1316000	1316000
Sole soybean + 300 kg/ha N:P:K	-	1.00	1.00	-	1144500	1144500
Sole soybean + 400 kg/ha N:P:K	-	1.00	1.00	-	1337000	1337000
Rice + soybean + 0 kg/ha N:P:K	0.87	0.74	1.61	704000	563500	1267500
Rice + soybean + 100 kg/ha N:P:K	0.87	0.66	1.53	995500	794500	1790000
Rice + soybean + 200 kg/ha N:P:K	0.45	0.66	1.11	643500	868000	1511500
Rice + soybean + 300 kg/ha N:P:K	0.60	0.70	1.29	1193500	798000	1991500
Rice + soybean + 400 kg/ha N:P:K	0.54	0.77	1.32	858000	1036000	1894000

Table end

	Land equivalent ratio (LER)			Gross monetary return (N:K)		
	Partial		Total			
	Rice	Soybean				
	2018 Rice Soybean Total					
Sole rice + 0 kg/ha N:P:K	1.00	-	1.00	1380000	-	1380000
Sole rice + 100 kg/ha N:P:K	1.00	-	1.00	1795000	-	1795000
Sole rice + 200 kg/ha N:P:K	1.00	-	1.00	1935000	-	1935000
Sole rice + 300 kg/ha N:P:K	1.00	-	1.00	1745000	-	1745000
Sole rice + 400 kg/ha N:P:K	1.00	-	1.00	1740000	-	1740000
Sole soybean + 0 kg/ha N:P:K	-	1.00	1.00	-	270000	270000
Sole soybean + 100 kg/ha N:P:K	-	1.00	1.00	-	372000	372000
Sole soybean + 200 kg/ha N:P:K	-	1.00	1.00	-	366000	366000
Sole soybean + 300 kg/ha N:P:K	-	1.00	1.00	-	426000	426000
Sole soybean + 400 kg/ha N:P:K	-	1.00	1.00	-	810000	810000
Rice + soybean + 0 kg/ha N:P:K	0.79	0.71	1.50	1095000	192000	1287000
Rice + soybean + 100 kg/ha N:P:K	0.67	0.81	1.48	1210000	300000	1510000
Rice + soybean + 200 kg/ha N:P:K	0.74	0.75	1.49	1425000	276000	1701000
Rice + soybean + 300 kg/ha N:P:K	0.77	0.92	1.69	1340000	393000	1733000
Rice + soybean + 400 kg/ha N:P:K	0.90	0.61	1.51	1565000	489000	2054000

CONCLUSIONS

Based on the result of this investigation, it was observed that the cropping system and increased fertiliser rates positively affected upland rice's growth and yield component. It was noted that the

N:P:K fertiliser rate (400 kg/ha) gave the highest growth and yield component of upland rice in the rice/soybean intercropping system, indicating that the optimum fertiliser rate is yet to be achieved from the study.

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