EVALUATING NITROGEN AND PHOSPHORUS REQUIREMENT FOR THE ECONOMICAL HARVEST OF RICE GENOTYPE 'NIA-19/A'

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ABSTRACT: *Balanced fertilization is imperative to achieve economic harvest from any crop. To evaluate nitrogen (N) and phosphorus (P) requirement of rice genotype 'NIA-19/A', consecutive (kharif 2013 and 2014) field studies were conducted at the experimental farms of Nuclear Institute of Agriculture (NIA), Tando Jam. The experiments were carried out in randomized complete block design (RCBD) with fixed layout having three replicates. Three levels of nitrogen (90, 120 and 150 kg N ha^{-1}) and nine levels of phosphorous (23, 30, 40, 45, 60, 70, 75, 90 and 110 kg P_2O_5 ha^{-1}) were used in three different combinations along with control (no fertilizer) treatment. Nitrogen and P rates significantly ($P < 0.05$) influenced the growth and yield of genotype. The pooled analysis data showed that the highest paddy yield (5.27 t ha^{-1}), number of productive tillers $plant^{-1}$ (14.3), number of grains $panicle^{-1}$ (117.5), 100-grain weight (3.07 g) were recorded at 150:75 kg N: P_2O_5 ha^{-1}, while the highest straw yield (10.2 t ha^{-1}) and plant height (107. 4 cm) was achieved at 150:110 kg N: P_2O_5 ha^{-1}. Moreover, maximum total uptake of N (149.1 kg ha^{-1}) and P (22.5 kg ha^{-1}) was recorded at 150:75 kg N: P_2O_5 ha^{-1}. The highest total recovery of N (69.8%) and P (30.9 %) was observed at 120:90 and 120:30 kg N: P_2O_5 ha^{-1}, respectively. Thus, the application of N: P_2O_5 @ 150:75 kg ha^{-1} was found as the most economical dose to achieve the maximum harvest from rice genotype 'NIA-19/A'.*

Keywords: Balanced fertilization, Economical harvest, Nitrogen, Rice genotype

INTRODUCTION

Rice (*Oryza sativa* L.) belonging to family *Gramineae* is a staple food grain crop which is consumed by more than half of the world's population [1]. It is cultivated on an area of 162 m ha around the globe, while 91 percent is being produced in less developed countries, particularly in Asia including Pakistan [2]. Rice comes among the major exportable items and is a source of largest foreign exchange earning in Pakistan, contributing 3.2% to the value addition in agriculture and 0.7% to GDP. In Pakistan, rice was cultivated on an area of 2.89 m ha during 2014-15 with total production of 7.0 m tons while average yield stood at of 2.44 tons ha^{-1} [3]. Rice is known to provide 19 and 13 percent human per capita energy and protein, respectively and provides >70% calories to the population of Asian countries [2]. However, considering the future demand of growing world, rice production needs to be increased during the coming decade by 1.2-1.5% annually [4].

Nitrogen plays a crucial role in rice production but its excess delays maturity and unnecessarily prolongs growth duration by encouraging vegetative growth [5]. It is essential component of many plant compounds such as enzymes, proteins, chlorophyll, alkaloids, hormones and vitamins [6]. Absorbed N during vegetative period is translocated to contribute in growth during reproductive and grain filling phase [7]. Nitrogen has positive influence on yield and yield attributes while its sub-optimal application drastically reduces yield [8]. Phosphorus being an essential constituent of many macro-molecules like DNA, RNA, ATP, phosphate esters and phospholipids, is involved in array of plant biochemical, physiological and molecular processes [9, 10]. It plays role in N-fixation, enzymes activation/inactivation, glycolysis, photosynthesis, respiration, energy generation, redox reactions, membrane stability and plant signalling processes [11, 12]. Phosphorus deficiency is major restrictive factor in plant growth and development influencing flowering and ripening, thereby limiting crop yield [13].

In Asia, plots dedicated to grow rice are extremely small accompanied by existing higher variations in nutrient requirements and nutrient balances within a particular landscape. These variations might be primarily due to differences in inherent soil fertility, historical fertilizer use, organic amendments, retention of crop residues and other farm management practices [14]. Farmers require actionable information regarding fertilizer recommendations which fulfill their particular situation demands [15]. Nitrogenous and phosphatic fertilizers are often applied in large quantities in agricultural systems because deficiency of either nutrient triggers complex physiological and molecular responses that ultimately lead to yield losses [16]. Inorganic fertilizers are very precious, expensive but essential input in the modern intensive farming systems. Presently, world is facing the shortage of major fertilizer nutrients particularly N and P primarily due to energy crises, finite phosphate rock reserves, geopolitics, price hicking and their non availability at critical time [17,18]. Therefore, the determination of most appropriate and economical dose of chemical fertilizer is imperative to enhance sustainable crop production [19]. Inter and intra varietal variations exist to respond applied N and P fertilizer based on their agronomic traits. Both crop yield and quality is remarkably affected when N or P fertilizers are applied in excess or below optimum rate [20]. Judicious and proper fertilization is an important management practice which increases fertilizer use efficiency, crop yield and quality [1]. Hence, present piece of work broadly focuses on ascertaining the nutritional requirements and to identify the balanced as well as economical dose of N & P fertilizers to achieve maximum potential of rice genotype 'NIA-19/A' under the agro-climatic conditions of Tando Jam, Sindh, Pakistan.

MATERIALS AND METHODS

Field studies were carried out for two consecutive years (2013 & 2014) during kharif season at the experimental farms of Nuclear Institute of Agriculture (NIA), Tando Jam to assess the economical dose of N and P for rice genotype

'NIA-19/A' evolved at NIA, Tando Jam. The various chemical and textural properties of the experimental site are presented in the table 1. Urea, single super phosphate (SSP), sulfate of potash (SOP) and zinc sulfate ($ZnSO_4$) were used as a source of nitrogen, phosphorus, potash and zinc (Zn), respectively. Three levels of nitrogen (i.e. 90, 120 and 150 kg ha^{-1}) and nine levels of phosphorous (i.e. 23, 30, 40, 45, 60, 70, 75, 90 and 110 kg P_2O_5 ha^{-1}) were used to formulate various treatment combinations. There were 10 treatments receiving combinations of different levels of N & P viz., control (without N and P), 90-23, 90-45, 90-70, 120-30, 120-60, 120-90, 150-40, 150-75 and 150-110 kg N-P_2O_5 ha^{-1}. Potash and Zn were applied to all experimental units at constant rate of 25 and 10 kg ha^{-1}, respectively. The experiment was carried out using randomized complete block design (RCBD) with fixed layout having three replicates during both years. The individual plot size was 4 m × 4 m. The required quantities of P and K were applied at the time of transplanting while Zn was applied after 15 days of planting in order to minimize the interaction between applied P and Zn. Urea was applied in three splits viz., at transplanting, at 50% tillering and at panicle initiation stage.

Seeds of rice genotype 'NIA-19/A' were sown in first week of June to grow rice nursery and 40 days old seedlings were transplanted manually as two plants per hill with 20 cm row to row and plant to plant distance during both years of trial. Intercultural management operations and other plant protection measures were uniformly adopted for all treatments throughout the vegetative and reproductive duration of crop. The crop was harvested at full maturity and separated into paddy and straw. The samples of grain and straw were dried in an oven at 70^0C until constant weight. Dried plant material was finely ground in Willey's mill fitted with stainless steel blades. Wet digestion procedure [21] was adopted for full recovery of phosphorus from plant material. Uniform portion of ground material was weighed and digested in Di-acid mixture (HNO_3: $HClO_4$) prepared in 5:1 ratio. Total P in the digested material was determined by vanadate-molybdate yellow color method [22]. Nitrogen was determined by digesting material following modified Kjeldahl's method [23] which converts N into NH_4^+ form in the presence of H_2SO_4. Soil samples were analyzed for EC and pH [24]. Soil texture was determined by standard method [25] using mechanical shaker and hydrometer. Total (paddy + straw) N or P recovery was calculated as total N or P uptake from fertilized treatments minus total N or P uptake from unfertilized treatment (control) and dividing by N or P fertilizer applied. Total recovery of fertilizer nitrogen or phosphorus was expressed as a percentage of applied fertilizer.

Statistical analysis

The results obtained for various parameters were statistically analyzed employing computer based software "STATISTIX 8.1". Comparison among treatment means was performed to identify significant differences (P < 0.05) using Least Significant Difference (LSD) test [26].

Table 1: Some chemical and textural properties of the experimental site used for study

Parameter	0-15 cm depth	15-30 cm depth
EC_e (dS m^{-1})	2.3	2.1
pH_e	7.8	7.6
Kjeldahl Nitrogen (%)	0.077	0.036
AB-DTPA extractable P (ppm)	5.51	3.01
AB-DTPA extractable K (ppm)	178	92
Organic matter (%)	0.91	0.68
Sand (%)	21.67	23.09
Silt (%)	42.23	41.11
Clay (%)	36.11	35.80
Soil Texture	Clay loam	Clay loam

RESULTS AND DISCUSSION

Agronomic parameters

Various nitrogen and phosphorus combinations significantly (P < 0.05) influenced different agronomic attributes such as plant height, number of productive tillers per plant, number of grains per panicle and 100-grain weight. The data regarding plant height showed that plant height was influenced significantly (P < 0.05) by different N and P levels (Table 2). Numerically maximum plant height (107.41 cm) was recorded in plots where N and P_2O_5 were applied @ 150 kg and 110 kg ha^{-1}, which was statistically at par with 150 kg N and 75 kg P_2O_5 ha^{-1}. Control treatment resulted in minimum plant height (85.75 cm). These results are in accordance with those of [20, 27], who disclosed that increased plant height with corresponding increase in N level might be due to enhanced vegetative growth. Adequate N supply causes alterations in hormonal balances resulting in excessive growth of shoots at the expense of roots [15]. The number of productive tillers per plant increased significantly (P < 0.05) with the increase in N and P application (Table 2). The highest number of productive tillers per plant (14.33) was observed in treatment receiving 150 kg N and 75 kg P_2O_5 ha^{-1}, while minimum productive tiller count (8.83) was recorded in unfertilized (control) treatment. Adequate P application is necessary to help rice plants to tailor P absorption for increased productive tillering [28].

Application of different levels of N and P influenced significantly (P < 0.05) the number of grains per panicle (Table 3). Fertilized plots resulted in higher number of grains per panicle as compared to unfertilized plots. The higher number of grains per panicle (117.54) was observed where 150 kg N and 75 kg P_2O_5 was applied while control treatment yielded least number of grains per panicle (82.96). Adequate supply of N to the plants favors better development of panicle and total grain per panicle by increasing cell division and cell elongation [29]. Increased number of grains per panicle might be primarily due to more availability of N at flowering and fruiting stage with higher partitioning of dry matter at seed formation. According to [30], the highest number of filled grains per panicle was recorded where 120 kg N and 26 kg P_2O_5 ha^{-1} was applied. Others [31, 32, 33] reported that grain number per panicle is affected significantly with increasing P rates. The 100-grain weight by rice plants was significantly (P < 0.05) increased with increasing rates of N and P fertilizer (Table 3). The highest 100-grain weight (3.07 g) was recorded in the plots which were fertilized with 150 kg N and 75 kg P_2O_5 ha^{-1} and these results were statistically similar with those obtained with 120 kg N and 90 kg P_2O_5 ha^{-1}. Unfertilized (control) treatment resulted in minimum 100-grain weight (1.58 g). Increase in grain weight with subsequent N and P application might be due to enhanced leaf chlorophyll contents and photosynthetic rate ensuring plenty of photosynthates during grain filling. Comparable results were recorded by [34, 35].

Paddy and straw yield (t ha^{-1})

The data pertaining to paddy yield (Table 4) revealed a significant (P < 0.05) increase in paddy yield with the increase of N and P fertilizer rates. The treatment fertilized with 150 kg N and 75 kg P_2O_5 resulted in highest paddy yield (5.27 t ha^{-1}) and it was statistically at par with the treatments, i.e. 120:90 and 150:110 kg N: P_2O_5 ha^{-1}. Minimum paddy yield (2.01 t ha^{-1}) was observed in control treatment. The higher paddy yield at elevated N and P rates has also been reported by [36]. Adequate P nutrition substantially contributed to the development of root system thereby increasing water and nutrients absorption and ultimately more biological yield. An imbalanced ratio of N and P reduces the number of grains per panicle and 100-grain weight.

Table 2: Influence of various N and P fertilizer levels and ratios on agronomic parameters of rice genotype 'NIA-19/A'

Treatments (N-P_2O_5 kg ha^{-1})	Plant height (cm)			Productive tillers $plant^{-1}$		
	2013	2014	Mean	2013	2014	Mean
Control	88.50 d	83.00 f	85.75 f	8.67 e	9.00 d	8.83 d
90-23 (4:1)	94.58 c	93.00 e	93.79 e	10.58 d	12.00 c	11.29 c
90-45 (4:2)	94.17 c	93.87 de	94.02 e	10.92 cd	11.53 c	11.23 c
90-70 (4:3)	95.92 bc	96.00 d	95.96 d	11.00 cd	14.87 a	12.93 b
120-30 (4:1)	94.00 c	94.07 de	94.03 e	11.00 cd	14.47 ab	12.73 b
120-60 (4:2)	98.17 b	100.00 c	99.08 c	11.42 bcd	14.53 ab	12.98 b
120-90 (4:3)	104.50 a	105.33 b	104.92 b	12.58 abc	15.00 a	13.79 ab
150-40 (4:1)	96.17 bc	104.60 b	100.38 c	10.58 d	14.87 a	12.73 b
150-75 (4:2)	104.42 a	106.57 ab	105.49 ab	13.33 a	15.33 a	14.33 a
150-110 (4:3)	106.75 a	108.07 a	107.41 a	13.00 ab	13.40 b	13.20 b
LSD	**2.77**	**2.17**	**1.89**	**1.84**	**1.17**	**1.09**

Means with different letter(s) in the same column are significantly different from each other at 5% level of significance

Table 3: Influence of various N and P fertilizer levels and ratios on agronomic parameters of rice genotype 'NIA-19/A'

Treatments (N-P_2O_5 kg ha^{-1})	No. of grains $panicle^{-1}$			100-grain weight (g)		
	2013	2014	Mean	2013	2014	Mean
Control	85.58 d	80.33 e	82.96 f	1.69 e	1.47 g	1.58 f
90-23 (4:1)	100.17 c	98.33 d	99.25 e	2.59 d	2.35 f	2.47 e
90-45 (4:2)	103.33 c	104.67 c	104.00 d	2.77 c	2.62 e	2.70 d
90-70 (4:3)	109.92 b	103.33 c	106.63 c	2.82 c	2.74 de	2.78 c
120-30 (4:1)	104.33 c	100.11 d	102.22 d	2.86 bc	2.92 bc	2.89 b
120-60 (4:2)	108.92 b	105.67 c	107.29 c	2.91 bc	2.93 abc	2.92 b
120-90 (4:3)	116.75 a	113.22 a	114.99 b	3.01 ab	3.05 a	3.03 a
150-40 (4:1)	109.50 b	105.22 c	107.36 c	2.92 abc	2.81 cd	2.87 bc
150-75 (4:2)	120.08 a	115.00 a	117.54 a	3.10 a	3.04 ab	3.07 a
150-110 (4:3)	117.08 a	110.44 b	113.76 b	2.89 bc	2.92 bc	2.90 b
LSD	**4.55**	**2.68**	**2.53**	**0.18**	**0.13**	**0.08**

Means with different letter(s) in the same column are significantly different from each other at 5% level of significance

Phosphorus fertilization enhanced average grain yield by 20 percent in an experiment conducted by [37]. The pooled data of straw yield (Table 4) showed that straw yield significantly (P < 0.05) and progressively increased with the N and P fertilizer application. The maximum straw yield of 10.24 t ha^{-1} was noted where N along with P was applied @ 150 kg N and 110 kg P_2O_5 ha^{-1} while control treatment yielded least straw yield (3.92 t ha^{-1}). Enhancing vegetative growth is the most important function attributed to N, thus straw yield increases with subsequent increase in N application [38]. Phosphorus has an additive effect on plant growth when applied with N in balance proportions [39].

Nitrogen and phosphorus uptake (kg ha^{-1})

Nitrogen and P uptake by the rice genotype was influenced significantly (P < 0.05) with increasing rates of N and P_2O_5 (Table 5). Nitrogen uptake showed positive linear trend with corresponding increase in N application rate. The maximum total N uptake (149.10 kg ha^{-1}) was recorded with 150 kg N ha^{-1} while least total N uptake (50.89 kg ha^{-1}) by rice plants was obtained in control treatment. At each N level, successive increase in P fertilization enhances significantly (P < 0.05) N use efficiency reflecting synergism between both nutrients. These results are similar to the findings of [36, 40, 41]. The data depicted in table 5 revealed that applied P_2O_5 levels influenced significantly (P < 0.05) total P uptake. Total P uptake escalated from 7.91 to 22.49 kg ha^{-1} when P_2O_5 rate was increased from 0 to 110 kg ha^{-1}. The maximum total P uptake (22.49 kg ha^{-1}) was recorded in the treatment supplied with 75 kg P_2O_5 ha^{-1} which was statistically at par with 90 and 110 kg P_2O_5 ha^{-1}, while minimum P uptake (7.91 kg ha^{-1}) was noticed in control treatment (unfertilized plots). These results conformed to the findings of [42]. According to [36], the highest P uptake of 17.9 kg ha^{-1} was noticed with 135 kg P_2O_5 ha^{-1}. About 53% increase in P uptake has been reported with P fertilization as compared to control [37].

Nutrient recoveries (%)

The data in table 6 showed significant ($P < 0.05$) effect of N and P_2O_5 levels on nutrient recoveries by rice crop. The maximum total N recovery (69.84 %) was noticed where 120 kg N and 90 kg P_2O_5 ha^{-1} were applied which was statistically at par with 150 kg N and 75 kg P_2O_5 ha^{-1}, while the lowest N recovery (33.62 %) was recorded where 90 kg N and 23 kg P_2O_5 ha^{-1} was applied. These findings are in close conformity with the results of [42]. The highest total P recovery (31.52 %) was achieved in treatment receiving 40 kg P_2O_5 ha^{-1} which was statistically identical with 30.97 % obtained at 30 kg P_2O_5 ha^{-1}. The minimum P recovery of 12.07 % was recorded at 110 kg P_2O_5 ha^{-1}. Total N recovery was decreased significantly ($P < 0.05$) with the subsequent increase in N levels (Table 6). Similar findings have been revealed by [39].

Economics analysis

Presently, there are no production policies or guidelines for farmers to decide their production plans except the price index. Economic feasibility of nutrient inputs is excellent criteria used to determine the value of commodity produced and net generated profit [36, 43]. The economic analysis regarding net income and value cost ratio for the test genotype is reflected in the table 7. The highest profit of Rs. 44309 ha^{-1} was gained where N: P_2O_5 were applied @ 150:75 kg ha^{-1}, while minimum profit (Rs. 15769 ha^{-1}) was attained with 90 kg N and 23 kg P_2O_5 ha^{-1}. The maximum value cost ratio (3.18) was observed in treatment fertilized with 150 kg N + 40 kg P_2O_5 ha^{-1}, while the lowest value cost ratio (2.57) was noticed where 90 kg N and 23 kg P_2O_5 ha^{-1} were applied. The value cost ratios at various combinations of N and P clearly indicated that VCR increase upto a certain levels of nutrients and beyond that rate it tends to decrease or marginally increases. Excessive fertilization above optimum rate is neither economical nor profitable. Therefore, judicious and balanced application of costly fertilizers are of significant importance to get higher economical harvests.

Table 4: Paddy and straw yield of rice genotype 'NIA-19/A' as affected by different N & P levels and ratios

Treatments (N-P_2O_5 kg ha^{-1})	Yield (t ha^{-1})					
	Paddy			Straw		
	2013	2014	Mean	2013	2014	Mean
Control	2.15 g	1.87 f	2.01 g	4.24 d	3.59 f	3.92 e
90-23 (4:1)	3.58 f	3.02 e	3.30 f	5.79 c	4.69 ef	5.24 d
90-45 (4:2)	3.66 f	3.65 de	3.66 ef	5.96 c	5.25 de	5.60 d
90-70 (4:3)	4.30 e	3.81 cd	4.05 de	6.27 c	5.46 de	5.87 d
120-30 (4:1)	4.17 e	3.69 de	3.93 de	5.86 c	5.93 d	5.90 d
120-60 (4:2)	4.55 de	4.02 bcd	4.29 cd	7.75 b	7.36 c	7.56 c
120-90 (4:3)	5.29 ab	4.71 ab	5.00 ab	8.19 b	7.85 bc	8.02 c
150-40 (4:1)	4.89 cd	4.51 abc	4.70 bc	8.11 b	8.37 bc	8.24 c
150-75 (4:2)	5.44 a	5.10 a	5.27 a	9.75 a	8.76 ab	9.26 b
150-110 (4:3)	4.98 bc	4.88 a	4.93 ab	10.60 a	9.87 a	10.24 a
LSD	**0.39**	**0.75**	**0.48**	**0.90**	**1.16**	**0.87**

Means with different letter(s) in the same column are significantly different from each other at 5% level of significance

CONCLUSION AND RECOMMENDATIONS

Yield potential of rice genotype 'NIA-19/A' can be exploited to a higher extent by the wise management of nitrogen and phosphorus application. The results of present study illustrated that 150 kg N plus 75 kg P_2O_5 ha^{-1} in the ratio of 4:2 can be considered as the most balanced and economical dose for genotype 'NIA-19/A' to achieve its maximum potential under the agro-climatic conditions of Tando Jam, Sindh, Pakistan.

Table 5: Effect of different N & P fertilizer levels and ratios on total N and P uptake

Treatments (N-P_2O_5 kg ha^{-1})	Total N uptake (kg ha^{-1})			Total P uptake (kg ha^{-1})		
	Paddy + Straw			Paddy + Straw		
	2013	2014	Mean	2013	2014	Mean
Control	52.81 e	48.97 i	50.89 h	8.24 g	7.58 f	7.91 e
90-23 (4:1)	82.59 d	79.69 h	81.14 g	13.48 f	13.04 e	13.26 d
90-45 (4:2)	91.00 cd	85.29 gh	88.15 f	16.06 e	17.02 c	16.54 c
90-70 (4:3)	98.38 c	91.50 fg	94.94 e	16.97 de	15.88 cd	16.43 c
120-30 (4:1)	94.67 c	93.52 f	94.09 ef	18.00 cd	15.71 cd	16.86 c
120-60 (4:2)	115.37 b	109.52 e	112.45 d	18.06 cd	14.61 d	16.34 c
120-90 (4:3)	136.76 a	132.64 c	134.70 b	23.13 a	20.84 b	21.98 a
150-40 (4:1)	119.28 b	120.00 d	119.64 c	19.72 bc	21.38 b	20.55 b
150-75 (4:2)	146.24 a	151.97 a	149.10 a	21.48 ab	23.51 a	22.49 a
150-110 (4:3)	147.22 a	142.09 b	144.66 a	21.90 a	20.94 b	21.42 ab
LSD	**12.03**	**7.22**	**6.48**	**1.92**	**1.41**	**1.32**

Means with different letter(s) in the same column are significantly different from each other at 5% level of significance

Table 6: Nutrient recoveries influenced by various N and P fertilizer levels and ratios

Treatments (N-P_2O_5 kg ha^{-1})	Total N recovery (%)			Total P recovery (%)		
	Paddy + Straw		Mean	Paddy + Straw		Mean
	2013	2014		2013	2014	
Control	0.00 f	0.00 f	0.00 g	0.00 e	0.00 g	0.00 f
90-23 (4:1)	33.10 e	34.14 e	33.62 f	22.76 b	26.28 c	24.52 b
90-45 (4:2)	42.43 cd	40.36 d	41.40 e	17.37 c	21.24 d	19.30 c
90-70 (4:3)	50.63 bc	47.26 c	48.95 cd	12.47 d	12.75 f	12.61 e
120-30 (4:1)	34.88 de	37.13 de	36.00 f	32.54 a	29.40 b	30.97 a
120-60 (4:2)	52.14 b	50.46 c	51.30 c	16.37 cd	12.34 f	14.36 de
120-90 (4:3)	69.96 a	69.72 a	69.84 a	16.54 cd	17.97 e	17.26 d
150-40 (4:1)	44.31 bc	47.35 c	45.83 de	28.70 a	34.35 a	31.52 a
150-75 (4:2)	62.29 a	68.67 a	65.48 ab	17.65 c	21.84 cd	19.74 c
150-110 (4:3)	62.94 a	62.08 b	62.51 b	12.41 d	11.72 f	12.07 e
LSD	**8.39**	**5.18**	**4.58**	**4.46**	**2.56**	**2.64**

Means with different letter(s) in the same column are significantly different from each other at 5% level of significance

Table 7: Value cost ratios (VCR) at various levels and ratios of N & P for rice genotype 'NIA-19/A'

Treatments (N-P_2O_5 kg ha^{-1})	Net production value (Rs) @ Rs 800 per 40 kg of rice paddy	Fertilizer cost (Rs)	Profit (Rs)	VCR
Control	---	---	---	---
90-23 (4:1)	25800	10041	15769	2.57
90-45 (4:2)	33000	12534	20466	2.63
90-70 (4:3)	40800	15368	25432	2.66
120-30 (4:1)	38400	13313	25087	2.88
120-60 (4:2)	45600	16713	28887	2.73
120-90 (4:3)	59800	20112	39688	2.97
150-40 (4:1)	53800	16924	36876	3.18
150-75 (4:2)	65200	20891	44309	3.12
150-110 (4:3)	58400	24857	33543	2.35

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