Impact of Conjunctive use of Oryza Sativa Nutrients on crop Growth, yield, and Fertility of soil in Helianthus Annuus Sequence

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Abstract*: To examine the impact of the conjunctive usage of Oryza sativa L. (rice) on Helianthus annuus (sunflower), a field study was conducted at the Experimental Farm of the Annalai University in 2017. Rice was fertilized by using the 75% of the recommended level of 120 kg of N/ha and was supplemented with 25% of N by implementing organic sources resulting in the removal of the nitrogen (N), phosphorus (P) and potassium (K) from the soil and yielded more seed (39.97q/ha) compared to the N application by using fertilizer only. The substitution of 25% N by the bulky organic manure of FYM and vermi-compost increased the total yield from 42.91 to 43.67 q/ha. When green leafy manures (Gliricidia and sunnhemp) replaced the 25% N, the yield was increased from 41.83 to 43.90 q/ha. However, the decrease from 75% to 50% in the level of fertilizers of the recommended level of 80, 50, and 30 kg/ha of NPK resulted in the reduced plant height, capitulum diameter, filled seeds/capitulim and seed yield of sunflower. The application of the 120 kg N/ha yielded 8.18N/ha of crop seed mean yield of the crop seed that was influenced by the residual nutrients to rice through the use of fertilizers. The application of 75% N through fertilizer and FYM or vermicomposting significantly increased the residual fertility of the nutrients of the sunflower seed yield to 9.23 and 9.14 q/ha, respectively. The sunflower seed yield also increased to 8.82 and 8.70 q/ha, due to the substitution of green leafy manures (Gliricidia and sunnhemp) to rice. The conjunctive source of fertilizer and organic manures used in rice in the rice–sunflower cropping system contained more N, P, and K compared to its initial values.

***Index Terms*: Conjunctive use of nutrients, Growth, Nutrient removal, Rice – Sunflower cropping system, Soil health, Yield**

I. INTRODUCTION

Diversification of crops specifically in rice-rice system with crops of low water requirement is the urgent need of the day. Several crops like wheat, maize, groundnut, sunflower etc. can replace rice in the winter *(rabi)* season following rainy-season *(kharif)* rice [1], [2]. The availability of water is becoming less with diminishing water-table and high evaporative demand during the post-rainy season. This warrants the selection of an ideal crop which requires less water, matures early and provides dependable yields. Sunflower is one such alternative crop to rice. The intensive cultivation of the 2 crops exhaust the soil nutrients. The application of high-analysis fertilizers makes the soil sick of several micronutrients [3]. Research on the partial substitution of nitrogenous fertilizer with organic sources of nutrients is useful in different rice-based cropping systems [1], [4]. Hence, there is need to test the validity of the conjunctive use of nutrients to evaluate the performance of two crops for the benefit of farmers.

II. MATERIALS AND METHODS

This experimental study was conducted during rainy *(kharif)* and winter *(rabi)* at Experimental Farm, Annamalai University under irrigated conditions. The experiment was laid out in different fields during the 2 years. The soil had pH 7.3 and 7.2 and electrical conductivity 0.24 and 0.30 dS/m, respectively, during 2001 and 2002. The initial value of the nitrogen content in the soil was comparatively low (215 and 210 kg/ha) compared to the medium level of phosphorus (26 and 24 kg P_2O_5/ha) and potassium (265 and 260 kg/K_2O/ha). Rice was grown with 8 treatments and 3 replications in randomized block design. They included no nitrogen, 75% and recommended level of N @ 120 kg/ha through fertilizer, 75%N through fertilizer and 25% N through the different organic sources *viz.* FYM, vermicompost, *Gliricidia* or sunnhemp. All the organic sources were applied 10 days before transplanting of rice. The rice crop was applied with the complete dosage of 60 kg P_2O_5 and 40 kg K_2O/ha along with 50% of N. The residual N content was spread on soil in two equal quantities at maximum tillering and panicle-initiation stages. Rice 'Tella Hamsa' was transplanted on 10 July in 2001 and 16 July in 2002 with a spacing of 20 cm × 10 cm. The sequence crop of sunflower hybrid 'APSH 11' was grown with 4 treatments as subplots in every treatment of previously grown rice considered as main plot in a split-plot layout. The spacing was 45 cm × 30 cm. The treatments included the recommended level of 80, 50 and 30 kg N, P and K/ha, and 75 and 50% recommended levels and no fertilizers. The rainfall during the growth period of rice was 640.3 mm in 2001 and 494.4 mm in 2002.

III. RESULTS AND DISCUSSION

A. Performance of rice

As per the Table 1, the rice variety responded to the increased level of nitrogen of nearly 120Kg/ha that was applied with the help of fertilizers. The plant height,

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number of tillers and panicles/hill were significantly reduced by the application of 75% recommended level of N. The quantity of N, P and K removed was also low. The seed yield was significantly reduced to 35.98 q/ha. Hence, rice was sensitive to sub-optimal dose of N application. Rice grown

Table 1. Growth, yield components and yield of rice as influenced by the conjunctive use of organic and inorganic source of nutrients

Treatment	Plant height (cm)	Tillers/ hill	Panicles/ hill	Filled grains/ panicle	1000 grain weight (g)	N removed (kg/ha)	P removed (kg/ha)	K removed (kg/ha)	Seed yield (q/ha)
No nitrogen	92.5	8.9	8.9	80.3	22.0	52.8	13.1	64.2	28.87
75% recommended dose of fertilizer nitrogen	100.0	10.3	9.2	100.9	23.5	72.7	72.7	83.1	35.98
Recommended dose of fertilizer nitrogen (120 kg/ha)	106.5	11.6	10.7	107.2	23.7	81.1	81.1	95.0	39.57
75% RDN + 25% N through FYM	106.2	12.8	12.4	102.7	24.1	89.3	89.3	102.0	43.67
75% RDN + 25% N through vermicompost	104.4	13.0	12.4	102.1	24.1	88.6	88.6	101.5	42.91
75% RDN + 25% N through *Gliricidia*	109.3	11.8	11.4	112.7	25.3	86.2	86.2	100.2	41.83
75% RDN + 25% N sunhemp	105.6	13.1	12.3	109.4	25.4	90.0	90.0	103.4	43.90
75% RDN + 1% polyfeed spray at panicle initiation, heading and flowering	106.6	11.8	10.7	103.2	23.7	84.9	84.9	95.0	40.94
CD (P=0.05)	4.5	0.6	9.4	9.4	0.8				1.96

without the addition of N showed stunted growth, produced less tillers and panicles/hill, grains/panicle and test weight. Ultimately, the crop produced least yield of 28.87 q/ha. The soil was poor in available nitrogen. Hence its available quantity through the soil mineralization was probably not sufficient to meet the crop requirement. This necessitated the liberal application of N through the fertilizer. It was also reported in a study by Mahavishnan [5] that the fertilization of rice variety by using the recommended level of N leads to increase in the net yield of the produce.

The conjunctive use of 75% N through fertilizer and 25% N through bulky organic manures with FYM or vermicompost significantly increased the mean rice yield compared to the application of 120 kg/ha recommended nitrogen as fertilizer. The crop also gave significantly more yield of by substituting 25% N with green leaf manure of sunnhemp and through *Gliricidia.* The slow decomposition of organic materials release the nutrients for a long time during the crop-growth period and also improves the soil physical properties. Hence the crop removed more N, P and K. Prasad (2000) also reported that the conjunctive use of N increased the yield of rice compared to the entire recommended N supplied through the fertilizer alone. But, Bhandari et al. [6] and Sujathamma [4] recorded no significant increase in yield of rice by conjunctive use of nutrients. Rice fertilized with 75% recommended level of N and sprayed with 1% poly feed at panicle initiation, heading and flowering gave mean seed yield of 40.94 q/ha. This was on a par with the yield obtained by the application of entire nitrogen through the fertilizer

A. Performance of sunflower and soil nutrient balance

An application of N to rice through the fertilizer did not carry a residual effect on the growth of succeeding sunflower. Sunflower fertilized with recommended level of 80, 50 and 30 kg N, P and K/ha responded to grow vigorously and gave more yield (Table 2). The unfertilized crop removed substantially low mean quantity of (24.5 kg N, 6.9 kg P and 36 kg K/ha) nutrients. It showed stunted growth. The capitulum diameter, seeds/capitulum and 1,000-seed weight were severely reduced. Hence the

crop gave low mean seed yield. The soil was severely depleted of N, P and K. It had a balance of 186.1, 19.5 and 235.1 kg /ha N, P, K compared to their initial availability of 215, 25 and 262 kg/ha. The yield increased by the application of 50 or 75% recommended level of fertilizers. But this was not sufficient to meet the crop requirement. Ali et al. [7] also reported that sunflower is highly sensitive to sub-optimal dose of fertilizer application. The crop fertilized with the recommended level of 80, 50 and 30 kg/ha NPK removed large quantities of these nutrients, improved the plant height, capitulum diameter and filled seeds/capitulum. The crop therefore gave maximum mean seed yield. The soil also had a balance of more quantity of 224.4 kg N, 28.6 kg P and 273.5 kg K7 ha compared to the initial level. The plant height, capitulum diameter, filled seeds/ capitulim and 1,000-seed weight were at par by growing sunflower after rice and fertilized with 120

Table 2. Growth, yield components and yield of sunflower as influenced by residual nutrients to rice and level of fertilizers to sunflower

Treatment	Plant height (cm)	Capitulum diameter (cm)	Filled seeds / head	1000 seed weight (g)	Seed yield (q/ha)	N removed (kg/ha)	P removed (kg/ha)	K removed (kg/ha)	Nutrient balance in soil (kg/ha)		
									N	P_2O_5	K_2O
Direct effect											
No fertilizers	110.0	10.8	281	36.4	5.73	24.5	6.9	36.0	186.1	19.5	235.1
50% recommended dose of fertilizers	118.4	13.8	415	38.4	8.09	41.2	12.1	54.7	202.3	23.1	252.7
75% recommended dose of fertilizers	119.2	14.2	417	39.1	8.91	48.6	15.9	62.2	214.5	126.6	284.0
Recommended dose of fertilizers (80:50:30 kg/ha NPK)	126.8	15.1	428	39.1	10.85	59.2	20.4	65.9	224.4	28.6	273.5
CD (P=0.05)	1.3	0.2	4	0.3	0.12						
Residual effect											
No nitrogen	113.7	12.6	368	37.3	6.67	33.0	10.2	45.4	183.5	21.1	229.5
75% Recommended dose of fertilizer nitrogen (RDFN)	117.7	13.2	377	37.4	8.34	42.1	13.0	55.2	192.9	22.5	245.4
Recommended dose of fertilizer nitrogen	119.0	13.4	383	37.7	8.18	41.8	12.9	54.4	200.8	22.9	258.7
75% RDFN + 25% N through FYM	120.3	13.0	396	38.2	9.23	48.5	15.7	60.6	217.4	25.7	265.6
75% RDFN + 25% N through vermicompost	120.5	14.3	394	38.4	9.14	47.9	15.5	60.8	218.9	26.0	266.0
75% RDRN+ 25% N through Gliricidia	119.9	14.1	357	39.6	8.82	47.6	15.8	61.0	224.5	27.6	270.0
75% RDFN+25% N through sunnhemp	123.1	14.3	421	39.6	8.70	46.0	15.2	59.0	247.1	27.1	268.9
75% RDFN+1% poly feed spray at panicle initiation, heading and flowering	117.1	13.2	384	37.5	7.98	40.5	12.5	53.2	193.8	22.7	246.5
CD (P=0.05)	6.6	0.7	32	2.0	0.52						

kg N/ha. But sunflower gave 8.11 q seed/ha when it was grown after rice fertilized with 120 kg N/ha. When rice was not fertilized with nitrogen, sunflower gave low yield. This was probably due to the low availability of nutrients, as they were severely mined by the nutrient exhaustive rice crop. The application of 120 kg N /ha to rice recouped its removal by the crop from the soil.

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Therefore, the succeeding sunflower was not severely deprived of the nutrient absorption. It could also be possible that the application of N to rice had synergistic effects with P and K. Although there was no great improvement in yield components of sunflower due to the effect of 120 kg N /ha applied to preceding rice, the increase in yield could probably be owing to the cumulative influence of little improvement.

The sunflower seed yield was increased by the fertilization of rice using 75% of the recommended level of N/ha and supplemented with 25% of N by implementing FYM, vermicompost, and *Gliricidia* or sunnhemp. The conjunctive use of nutrients instead of using fertilizers with N content in the rice-sunflower cropping system resulted in the increased content of N,P, and K in the soil.

The study indicated that the yield office and sunflower improved by the conjunctive nutrient management office while the soil health was also improved. Therefore, farmers have an option to substitute 25% N equivalent fertilizer with FYM, vermicompost, *Gliricidia* or sunnhemp, depending on their relative availability to sustain the level of food grain production and soil nutrients.

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