RESEARCH ARTICLE

CUMULATIVE AND RESIDUAL EFFECT OF YIELD AND NUTRIENT UPTAKE BY RICE UNDER GERANIUM (*PELARGONIUM GRAVEOLENS*) –RICE (*ORYZA SATIVA*) CROPPING SEQUENCE AS INFLUENCED BY LEVELS OF PHOSPHORUS AND ZINC

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Abstract : A field experiment was conduced at Central Institute of Medicinal and Aromatic Plant, Lucknow to influence the cumulative and residual effects of phosphorus and zinc source of nutrient uptake by rice under geranium-rice cropping sequence. The 18 treatment combination consisted of 3 cropping system viz. geranium paired sole (40/80cm.) garlic sole (20×10cm.), geranium paired + garlic (1:4), three levels of phosphorus (0, 30 & 60 Kg. P_2O_5 ha^{-1}) and 2 levels of zinc (0 and 25kg. Zn SO_4 ha^{-1}) were evaluated in a factorial RBD design with three replication. Higher uptake of P by rice in grain in the plots of 80kg P_20_5 ha^{-1} supplied to geranium clearly indicate that there is a residual effect of P on the P uptake by succeeding crop. Hence, there is a net saving of 30kg P_20_5 ha^{-1} to achieve similar yield level to that of 30kg P_20_5 ha^{-1} applied in the plots of geranium received 40kg P_20_5 ha^{-1}. P uptake by rice in grain was also enhanced upto 25kg $ZnSO_4$ ha^{-1} applied over 30kg $ZnSO_4$ ha^{-1} supplied to geranium crop. Residual effect of Zn on uptake of P fallowed the same trend to that of P – uptake under cumulative effect. Zn uptake by rice in grain increased significantly upto 30kg P_20_5 ha^{-1} in the cumulative treatment, However, under the residual treatment the uptake of Zn by rice in grain increased upto 80kg P_20_5 ha^{-1} applied to previous crop. Clearly indicate that higher doses of P may decrease the uptake of Zn by rice in grain. The net profit of rice after geranium paired system (Rs. 13,224.1 ha^{-1}) it was at par with rice after garlic sole (Rs. 13,758.1 ha^{-1}) system. Thus Geranium – rice sequence proved economical.

Keywords: Rice, Medicinal & Aromatic plants, Phosphorus, Zinc

INTRODUCTION

Geranium (*Pelargonium graveolens*) is a native of dry rockey slopes of cape province (South Africa) and has spread to different parts of world. At present china is the major producer. The crop was introduced in India during early part of 20th century and its cultivation gained commercial importance in high altitude of Palney, Shevroy and Nilgiri hills of Tamilnadu. Geranium is a crop of high value perfumery oil widely used in soaps, cosmetics and perfumery industries. Due to developmental activities in traditional areas of its cultivation, production of geranium oil has gone down from 20t to less than 2t per year. Thus there is an urgent need to increase the domestic production of geranium oil not only to meet our own needs but also save precious foreign exchange involved in its procurement. To achieve this, of late, geranium has successfully been introduced in northern plains of India as an annual crop. In an attempt to increase the production of geranium oil, successful efforts have been made to develop appropriate agro-technologies for its commercial cultivation, in the north Indian plains.

Phosphorus and zinc fertilizers have a carry over effects on the succeeding crops. The utilization efficiency of applied phosphatic fertilizers seldom exceeds 15% by the first crop, but a substantial amount of them is left as residue for the next crop (Roy *et al.*, 1978 and Mahala *et al.*, 2006). Geranium - rice is one of the important cropping systems in northern Indian plains, where the poor tribal farming community is not using phosphorus. Hence it become necessary to findout some low-priced indigenous alternative. Further more, in the north Indian plains, rice is grown as a major food crop during Kharif season. In the rice growing belt of the north Indian plains, geranium and upland rice can be grown in sequential cropping system. The recommendation for phosphorus and zinc are made crop based. Such recommendation do not take into account the carry over effect of quantity of nutrient applied to the preceding crop. Hence, rice though in sequence after the geranium cropping is fertilized with full dose of P and Zn. It is, therefore, imperative to study the residual effect of P and Zn on the grain yield of succeeding rice crop and also to workout, the requirement of nutrient for this crop when grown in sequential cropping system. So for, no research work has been carried out to study the nutritional requirement of the geranium – rice based cropping systems, Hence, the aim of the present study was to stabilized the production of geranium and garlic in intercropping system and also the succeeding upland rice crop of the geranium based cropping systems.

In the present investigation an attempt has been made to determine the yield and nutrient uptake of rice and levels of P and Zn application to achieve higher yield of rice with geranium – rice cropping sequence.

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MATERIAL AND METHOD

The experiment was conducted during 1998-1999 at Central Institute of Medicinal and Aromatic Plants Lucknow. The soil was sandy loam in texture and alkaline (pH 8.3) in reaction. The nutrients in the 0-15 cm soil layer were; Low (168.9 kg ha-^{1}) in N (Subbiah and Asija, 1956), Medium (21.6 kg ha^{-1}) in P_2O_5 (Olsen *et al.*, 1954) and K_2O 82.7 kg ha^{-1} (Jackson, 1967). The available Zn was 0.4 ppm, estimated by DTPA $CaCl_2$ TEA method. Three cropping systems (geranium paired sole, garlic sole and geranium paired + garlic), three levels of P (0, 40 and 80 kg P_2O_5 ha^{-1}) and two levels of zinc (0 and 30 kg Zn SO_4 ha^{-1}) were evaluate in experiment No. 2 during rabi season. The same layout was used to observe the residual and cumulative effects of the treatment on succeeding rice crop. A uniform dose of 120 kg. N and 60 kg. K_2O ha^{-1} was applied to the paddy crop. Phosphorus and Zinc fertilizers were applied basally as per the treatment at the time of planting. The potassium fertilizer was also applied basally at the time of planting. Nitrogen was top dressed in three equal proportion at 20, 40 and 60 days after planting. The cumulative effect was examined over the direct application of P (0, 30 and 60 kg P_2O_5 ha^{-1}) and Zn (0 and 25 kg $ZnSO_4$ ha^{-1}) were evaluated in a factorial randomized block design with three applications. The seeds of the variety pant – 12 were obtained from G.B. Pant University of Agriculture and technology Pantnagar. 25 days old seedlings were transplanted at a spacing of 20 × 10 cm using 2-3 seedlings per hill on 2 July 1999 and harvested at 100 days after transplanting. Observation on yield attribute and yield were recorded. Observation on dry matter content (%) and dry matter yield in rice was recorded. The 100 gm fresh plants samples were kept in oven for drying at 50-60^{0} for 48 hours. After proper drying, the plant samples weight was recorded and expressed as dry matter content (%). The dry matter content (%) was multiplied by biomass yield to obtain dry matter yield and expressed as quintals per hectare.

Phosphorus and zinc contents in Plant tissue were estimated in geranium and garlic at harvests. Samples were digested in di-acid and reading for P and Zn were recorded on Kletts colorimeter (Jackson, 1962 and AOAC, 1965) and atomic absorption spectro photometer (Lindsay and Norvell, 1978) respectively.

Nutrient uptake was calculated by multiplying the dry matter yield with nutrient content and expressed in kg ha^{-1}

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) in dry matter} \times \text{yield of dry matter (kgha}^{-1}\text{)}}{100}$$

RESULT AND DISCUSSION

Cumulative and residual effect of P and Zn in rice

Effect of P on yield attributes and yield in rice

Rice crop grown in the field plots after the harvest of geranium sole as well as intercropped geranium did not differ significantly in yield attributing characters. However, the application of P at 30(40) kg P_20_5 ha^{-1} and Zinc at 25(30) kg $ZnS0_4$ ha^{-1} showed an improvement both in development of panicles and grain. In the cumulative effect, the P levels were added both to geranium and rice crops. The significant differences in the yield attributes of rice at lower doses of P were mainly because of the residual effect of P applied (40 Kg P_20_5 ha^{-1}) to previous crop of geranium.

But higher doses of P applied to rice directly did not contribute significantly with respect to yield attributes. It is interesting to note that the grain weight per panicle of rice was observed significant at 60(80) kg P_20_5 ha^{-1} which was applied to rice crop directly in the plots of previous crop fertilized with 80 kg P_20_5 ha^{-1} (Table-1).As a result, the grain yield was found to be significant in the residual fertility soil status. This implies that the added fertilizer to the preceding geranium crop continued to have marginal residual effects in the succeeding rice crop. Present findings are supported by the observation made by other workers in food crops (Dev and Mistry, 1979, Wichmann, 1979, Mahala *et al.*, 2006 and Singh and singh 2006). Dang *et al* (1989) observed the residual effect of P in wheat - rice system and they found that P at 26.4 kg P_20_5 ha"^{1} in wheat increase the yield of wheat (674 kg ha^{-1}) as well as the yield of succeeding rice (712 kg ha^{-1}). P at the rate of 26.4 Kgha'^{1} used in rice also increased the yield of when the preceding wheat receiving no application, but up to 13.2 kg P ha^{-1} only when the preceding wheat received only 13.2 kg P ha^{-1}. Rathi and Yadav (1992) also reported that residual effect of P applied to pigeon pea crop was positive on grain yield of wheat. It is clear from the findings that the yield of rice grains under residual fertility status of P at 80 kg P_20_5 ha^{-1} supplied to geranium was almost equal to the yield of rice grain recorded with 30 kg P_20_5 ha^{-1} applied in the plot of 40 kg P_20_5 ha^{-1} received by previous crop of geranium. Therefore, it follows from the results that geranium crop followed by rice, 40 kg P_20_5 ha^{-1} is desirable particularly in Rabi crop season. But to grow rice after geranium 30 kg P_20_5 ha^{-1} is suggested (Table-2). On the other hand we can say that neither the higher doses of P (80 kg P_20_5 ha^{-1}) are required to geranium nor to rice (60 kg P_2O_5 ha^{-1})

Effect of Zn on yield attributes and yield in rice

Application of 25Kg $ZnS0_4$ ha^{-1} influenced significantly the yield attributing characters and grain yield on cumulative and residual soil fertility status. The requirement of Zinc for rabi crop of geranium is 30 Kg $ZnS0_4$ ha^{-1} and the rice crop grown in sequence after geranium is 25Kg $ZnS0_4$ ha^{-1}. It has been observed that soil application of $ZnS0_4$ at 20 Kg ha^{-1} to rice improve the grain yield in wheat (Prasad and Umar, 1993). Higher levels of P with Zinc may decrease the availability of Zn to the plants. Several workers have reported the P induced zinc deficiency in agricultural crop (Takkar 1989).

Cumulative and residual effects on uptake of P and Zn in the grain of succeeding rice crop:

Cumulative effect of P uptake by rice in grain reveled that there was a significant and progressive increase in P uptake by rice in grain with successive increase in P level from control to 60 kg P_2O_5 ha^{-1}. P uptake by rice grain up to 80 kg P_2O_5 ha^{-1} also increased on the residual fertility status of the soil. This might be due to residual effect of applied P to geranium. Sinha and Rai (1984) also noticed significant response of direct applied P to wheat grown on varied residual fertility. Thus, the P requirement of rice, especially where geranium in the preceding crop, could be reduced to 30 Kg P_2O_5 ha^{-1} in the cumulative effect of the treatment. Higher uptake of P by rice in grain in the plots of 80 kg P_2O_5 ha^{-1} supplied to geranium clearly indicate that there is a residual effect of P on the P uptake by succeeding crop. Hence, there is a net saving of 30 kg P_2O_5 ha^{-1} to achieve similar yield level to that of 30 kg P_2O_5 ha^{-1} applied in the plot of geranium received 40 kg P_2O_5 ha^{-1}. P uptake by rice in grain was also enhance up to 25 kg $ZnSO_4$ ha^{-1} applied over 30 kg $ZnSO_4$ ha^{-1} supplied to geranium crop. Residual effect of Zn on uptake of P followed the same trend to that of P – uptake under cumulative effect (Table-3). Zn uptake by rice in grain increased significantly up to 30 kg P_2O_5 ha^{-1} in the cumulative treatment. However, under the residual treatment the uptake of Zn by rice in grain increased up to 80 kg P_2O_5 ha^{-1} applied to previous crop. This clearly indicate that higher doses of P may decreased the uptake of Zn by rice in grain. Balanced supply of P up to 30 kg P_2O_5 ha^{-1} in the soil might have favored the efficient use of Zn by the rice crop. Prasad and Umar (1993) have also reported the similar results in rice-wheat rotation.

Gross return and net profit of rice cropping

Cumulative effect of the cost of production of rice was uniform under different cropping systems (Rs. 17380.4 ha^{-1}). But after the harvest of garlic sole crop, the higher net profit (Rs. 18,274.6) showed by rice crop indicated that there was a possibility of utilization of more nutrients and water by rice crop as compare to rice crop taken after the harvest of geranium sole and geranium + garlic intercrop. Residual effect of the cost of production rice was uniform under different cropping systems (Rs. 16,210.4 ha^{-1}). But in terms of net profit of rice after geranium paired system (Rs. 13,224.1 ha^{-1}). It was at par with rice after garlic sole (Rs. 13758.1 ha^{-1}) system. However, the net profit slightly decreased under rice grown after geranium paired + garlic combination.

Table 1. Fresh biomass and oil yields of geranium as influenced by different cropping systems and rates of phosphorus and zinc

Treatment	Biomass yield (q ha^{-1}) at			Oil yield (kg ha^{-1}) at		
	Ist harvest	IInd harvest	Total	Ist harvest	IInd harvest	Total
Cropping System						
Geranium paired sole (40/80 cm)	236.92	152.50	389.92	48.72	32.98	81.73
Garlic sole (20×10cm)	-	-	-	-	-	-
Geranium paired (40/80 cm) + Garlic	217.77	140.40	358.15	44.98	30.37	75.35
SEm	5.98	4.30	9.72	1.19	0.82	2.02
CD at 5%	17.54	NS	28.50	3.49	2.40	5.92
Phosphorus levels (Kg P_2O_5 ha^{-1})						
0	194.57	123.05	317.62	40.33	27.05	67.38
40	237.81	153.18	391.00	49.05	33.7	82.75
80	249.66	163.08	412.75	51.17	34.28	85.5
SEm	7.32	5.28	11.90	1.46	1.00	2.47
CD at 5%	21.48	15.48	34.92	4.28	2.94	7.25
Zinc levels (kg $ZnSO_4$ ha^{-1})						

0	214.23	137.42	351.65	44.30	29.72	74.00
30	2.40.46	155.45	395.90	49.40	33.63	83.08
SEm	5.98	4.31	9.72	1.19	0.82	2.02
CD at 5%	17.54	12.64	28.51	3.49	2.40	5.92

NS= Non significant

Table 2. Yield attributes & Bulb yield of garlic at harvest as influenced by different cropping systems and rates of phosphorus and zinc

Treatment	Diameter/bulb (cm)	No. of Cloves/bulb	Weight/bulb (gram)	Bulb yield (q ha^{-1})
Cropping System				
Geranium paired sole (40/80 cm)	4.55	15.82	32.11	122.24
Garlic sole (20×10cm)	-	-	-	-
Geranium paired (40/80 cm)+ Garlic	3.79	15.50	26.00	56.27
SEm	0.11	0.46	0.80	2.56
CD at 5%	0.33	NS	2.34	7.27
Phosphorus levels (kg P_2O_5 ha^{-1})				
0	3.90	12.97	22.17	80.02
40	4.19	16.18	29.5	90.78
80	4.42	17.83	35.50	96.96
SEm	0.14	0.57	0.98	3.14
CD at 5%	0.40	1.66	2.86	8.91
Zinc levels (kg $ZnSO_4$ ha^{-1})				
0	4.06	14.61	26.61	85.45
30	4.28	16.71	31.50	93.05
SEm	0.11	0.46	0.80	2.56
CD at 5%	NS	1.35	2.34	7.27

NS= Non significant

Table 3. P uptake (kg ha^{-1}) of rice as influenced by cumulative and residual effect of P and Zn under different cropping systems

Treatment	P uptake (kg ha^{-1}) at harvest			
	Cumulative		Residual	
	Grain	Straw	Grain	Straw
Cropping System				
Geranium paired sole (40/80 cm)	36.72	13.62	31.40	12.23
Garlic Sole (20×10 cm)	41.03	13.90	32.08	12.57
Geranium paired (40/80 cm) + Garlic	35.07	13.50	30.13	11.52
SEm	1.00	0.37	0.81	0.35
CD at 5%	2.89	NS	NS	0.99
Phosphorus levels (kg P_2O_5 ha^{-1})				
0 (0)	26.00	11.73	23.48	10.33
30 (40)	41.33	15.07	32.40	12.62
60 (80)	45.48	14.22	37.73	13.37
SEm	1.00	0.37	0.81	0. 35
CD at 5%	2.89	1.05	2.32	0.99

Zinc levels (kg $ZnSO_4$ ha^{-1})				
0 (0)	33.49	12.96	28.87	11.82
25 (30)	41.72	14.39	33.53	12.39
SEm	0.82	0.30	0.66	0.28
CD at 5%	2.36	0.86	1.89	NS

Table 4. Zn uptake (kg ha^{-1}) of rice as influenced by cumulative and residual effect of P and Zn under different cropping systems

Treatment	Zn uptake (kg ha^{-1}) at harvest			
	Cumulative		Residual	
	Grain	Straw	Grain	Straw
Cropping System				
Geranium paired sole (40/80 cm)	0.149	0.188	0.112	0.147
Garlic Sole (20×10 cm)	0.166	0.214	0.123	0.152
Geranium paired (40/80 cm) + Garlic	0.141	0.185	0.107	0.139
SEm	0.005	0.005	0.002	0.004
CD at 5%	0.013	0.14	0.007	0.012
Phosphorus levels (kg P_2O_5 ha^{-1})				
0 (0)	0.125	0.184	0.099	0.141
30 (40)	0.162	0.206	0.114	0.146
60 (80)	0.169	0.196	0.129	0.150
SEm	0.005	0.005	0.002	0.004
CD at 5%	0.013	0.014	0.007	NS
Zinc levels (kg $ZnSO_4$ ha^{-1})				
0 (0)	0.089	0.140	0.080	0.128
25 (30)	0.215	0.252	0.147	0.163
SEm	0.004	0.004	0.002	0.003
CD at 5%	0.011	0.012	0.005	0.009

Table 5. Effect of different cropping systems on gross return (Rs. ha^{-1}) and net profit (Rs. ha^{-1}) of rice crop

Treatment	Grain yield of rice (q ha^{-1})		Straw yield of rice (q ha^{-1})		Gross return (Rs. ha^{-1})		Cost of production (Rs. ha^{-1})		Net profit (Rs. ha^{-1})	
	C	R	C	R	C	R	C	R	C	R
Cropping System										
Geranium paired sole (40/80 cm) – Rice	49.09	44.32	60.87	56.85	32,497.50	29,434.50	17,380.40	16,210.40	15,117.10	13,224.10
Garlic Sole (20×10 cm) – Rice	53.88	45.10	66.54	58.17	35,655.00	29,968.50	17,380.40	16,210.40	18,274.60	13,758.10
Geranium paired (40/80 cm) + Garlic – Rice	47.14	41.88	59.52	53.72	31,260.00	27,814.00	17,380.40	16,210.40	13,879.60	11,603.60

C = Cumulative
R = Residual
N – Rs. 9.87 kg^{-1}, P – Rs. 19.50 kg^{-1}, K – Rs. 7.10 kg^{-1}, Rice Grain – Rs. 600.00 q^{-1}, Straw yield – Rs.50.00q^{-1}

CONCLUSION

It may be conducted that the result of cummulative & Residual effect of uptake of nutricians of rice under geranium – rice cropping sequence. Uptake of P&Zn is more in 30 Kg P_2O_5 & Zn 25 Kg ha^{-1} Over 60 Kg P_2O_5 & 30 Kg $ZnSO_4$ ha^{-1}. The net profit of rice after geranium paired system (Rs. 13,224.1 ha^{-1}) it was at par with rice after garlic sole (Rs. 13,758.1 ha^{-1}) system. Thus Geranium – rice sequence proved economical.

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