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Residual Effect of Rice Residue, FYM and Fertilizers on Growth, Yield and Quality of Summer Moong (*Vigna radiata* L.) in Rice-Potato-Summer Moong Cropping System

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ABSTRACT

Background: To work out the residual effect of rice residue, FYM and fertilizers on summer moong (*Vigna radiate* L.) in Rice-potato-summer moong cropping system.

Methods: The present study was carried out at Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab. The experiment was laid out in factorial randomized block design with two factors. Factor A contains five nutrient management treatments in potato (Rice residue+ 125 % NPK + 25 t ha^{-1} FYM, Rice residue + 100% NPK + 25 t ha^{-1} FYM, Rice residue+ 75% NPK + 25 t ha^{-1} FYM, Rice residue + 125% NPK + 0 t ha^{-1} FYM and Without rice residue + 100% NPK+ 50 t ha^{-1} FYM) and factor B contains three nitrogen levels in summer moong (0 kg ha^{-1} N, 6.25 kg ha^{-1} N and 12.5 kg ha^{-1} N).

Result: The plant height, branches, dry matter accumulation, LAI and chlorophyll content index were significantly affected with the treatments applied to preceding potato crop. The application of rice residue+ 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher plant height, branches, dry matter accumulation, LAI and chlorophyll content index of moong crop as compared to rice residue + 75% NPK + 25 t ha^{-1} FYM and rice residue+ 125% NPK + 0 t ha^{-1} FYM while at par to rice residue+ 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100 % NPK+ 50 t ha^{-1} FYM. The significantly higher biometric parameters were observed with 12.5 kg ha^{-1} N which was significantly higher than the 0 and 6.25 5 kg ha^{-1} N. The application of rice residue+ 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher yield and yield attributing characters as compared to rice residue+ 75% NPK + 25 t ha^{-1} FYM and rice residue+ 125% NPK + 0 t ha^{-1} FYM while at par to rice residue + 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100% NPK 50 t ha^{-1} FYM. The application of higher dose of nitrogen @ 12 kg ha^{-1} also significantly increased the yield and yield attributing characters as compared to lower doses of summer moong. The nutrients uptake (N,P and K) was also maximum with rice residue+ 125% NPK + 25 t ha^{-1} FYM which was at par to rice residue + 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100 % NPK + 50 t ha^{-1} FYM while significantly higher than other treatment. The application of higher dose of nitrogen @ 12 kg ha^{-1} in summer moong also significantly increased the nutrient uptake and protein content as compared to lower doses.

Key words: FYM, Nitrogen, Potato, Rice residue, Summer moong.

INTRODUCTION

The rice-wheat cropping system (RWCS) is the backbone of Indian farming, especially in the north-western region. But continuous adoption of the RWCS in northwest India has resulted in major challenges and stagnation in the productivity of this system. Several emerging problems, such as the exhausting nutrient pool in soil, deteriorating soil health, groundwater depletion, escalating production cost, labor scarcity, environmental pollution due to crop residue burning and enhanced greenhouse gas emissions, climatic vulnerabilities and herbicide resistance in weed species, are a few major threats to its sustainability. Modern concepts in crop production such as crop diversification with short duration crops varieties, conservation agriculture, integrated nutrient management, residue management, precision farming and different farming techniques has been developed to solve these issues and increased the production level, without hampering the natural resources. Mung bean (*Vigna radiata* L.) is an important legume or pulse crop, which can be a major component in different cropping systems. Short lived leguminous mung bean plants can be grown in various cropping patterns because they have the ability to adapt environmental stresses like drought, low soil fertility *etc* (Bourgault *et al*., 2010) and the inclusion of a grain legume in the cropping pattern will supply substantial amount of biomass and N to soil and thus improve soil fertility and crop productivity on sustainable basis (Ali *et al*., 2012). Currently, a major emphasis is being made on planning the nutrient management strategy based

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on the entire cropping system rather than focusing on individual crops because succeeding crops are influenced by inputs applied in preceding crops (Ratanoo *et al.* 2024). The responses of the succeeding crops in a cropping system are influenced greatly by the inputs applied in preceding crops (Devi *et al*., 2015). In context to diversify the existing rice-wheat cropping system, rice-potato-summer moong is high cropping intensity system with resource saving technologies can be practiced in Punjab to obtained higher yield and sustainable productivity.

MATERIALS AND METHODS

The present study was carried out at Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab (located at 30°56′N, 75°52′ and 247 m mean sea level) during three consecutive years (*rabi* and *kharif* season of 2020-21, 2021-22 and 2022-23). Ludhiana is situated in the central plain zone of Punjab in trans-gangetic agro-climatic zone of India. The climate of this region is semi-arid, sub-tropical with dry and hot summers during April to June, humid and hot monsoon periods during July to September, mild early winters during October to November and cold winters during December to February. The average annual rainfall of the region is 755 mm, out of which about 70% is received during July to September due to the south western monsoons. Meteorological data during the summer moong seasons revealed that average maximum and minimum temperatures were 38.6 and 14.4°C, respectively during the three years. Average relative humidity prevailed during the growing seasons of moong was between 52 (maximum) and 30% (minimum). The average total annual rainfall during the growing seasons of moong was recorded 52.8 mm. The experiment was laid out in factorial randomized block design with two factors. Factor A contains five nutrient management treatments in potato (Rice residue+ 125% NPK + 25 t ha^{-1} FYM, Rice residue + 100% NPK + 25 t/ha FYM, Rice residue+ 75% NPK + 25 t ha^{-1} FYM, Rice residue + 125% NPK + 0 t ha^{-1} FYM and Without rice residue + 100% NPK+ 50 t ha^{-1} FYM) and factor B contains three nitrogen levels in summer moong (0% of recommended N, 50% of recommended N and 100% of recommended N). All the fifteen treatment combination were randomized and replicated three times. Potato was planted as preceding crop to summer moong with recommended doses of fertilizers *i.e* 187.5 N, 62.5 P_2O_5 and 62.5 K_2O kg ha^{-1}. The nitrogen in summer moong was applied as per the treatment. The soil of experiment is normal in pH (7.6), low in organic carbon (0.34%), low in available nitrogen (130.5 kg ha^{-1}), low in available phosphorus (10.5 kg ha^{-1}) and medium in potassium (148.5 kg ha^{-1}). After harvesting of potato, summer moong was sown on 20th to 25th of March during all the years of experimentation. Summer moong was sown at row spacing of 22.5 cm with seed rate of 30 kg ha^{-1}. The average data of ten tagged plants from each plot were used for evaluating plant height (cm), dry matter accumulation (g/m^2), length of pod (cm), number of pods plant^{-1}, number of seeds pod^{-1} and 1000-seed weight. Seed yield and biological yield were calculated from net plot area and were converted into yield per hectare. Stover yield was computed by subtracting total seed yield from the total biological yield.

RESULTS AND DISCUSSION

Biometric observations

The first factor which affects the establishment of crops is germination. The treatments applied to preceding potato crop had non-significant residual effect on germination percentage of summer moong crop (Table 1). The plant height, branches and dry matter accumulation were significantly affected with the treatments applied to preceding potato crop (Table 1). The application of rice residue+ 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher plant height, branches and dry matter accumulation of moong crop as compared to rice residue+ 75% NPK + 25 t ha^{-1} FYM and rice residue+ 125% NPK + 0 t ha^{-1} FYM while at par to rice residue+ 100% NPK + 25 t ha^{-1} FYM and Without rice residue + 100% NPK+ 50 t ha^{-1} FYM during all the three year of study. This might be accorded to improving soil structure, enhancing soil fertility, increasing microbial activity (Zink and Allen, 1998) and improving the water holding capacity of the soil with the application of organic matter (Yadav *et al*., 2014), ultimately resulting into higher growth parameter of moong bean. This integrated nutrient management strategy not only enhances soil fertility and nutrient uptake but also contributes to the robustness of crops like mung bean against changing climatic conditions (Choudhary *et al.,* 2025). The increased dose of nitrogen from 0 kg ha^{-1} N to 12.5 kg ha^{-1} N significantly increased the growth parameter *viz.* plant height, branches and dry matter accumulation of moong bean. The significantly maximum plant height, branches and dry matter accumulation were observed with 12.5 kg ha^{-1} N which was significantly higher than the 0 and 6.25 kg ha^{-1} N. The LAI and chlorophyll content index were significantly affected by residual effect of integrated nutrients applied to preceding potato crop (Table 2). The maximum LAI and chlorophyll content index was observed with rice residue+ 125% NPK + 25 t ha^{-1} FYM applied to potato crop which were significantly higher than rice residue + 75% NPK + 25 t ha^{-1} FYM and rice residue + 125% NPK + 0 t ha^{-1} FYM while at par to rice residue + 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100% NPK + 50 t ha^{-1} FYM as per the data of three years. Organic matter acts as a reservoir of plant nutrients, chiefly N, P and S and it improves cation exchange capacity of soil (Brady and Weil, 2012), thus increased the nutrients availability and uptake to crop. Therefore increased nutrients availability and uptake results increased LAI and chlorophyll content of moong bean. The maximum LAI and chlorophyll content index was observed with 12.5 kg ha^{-1} N which was significantly higher than the 0 and 6.25 5 kg ha^{-1} N as per the data of three years. Razzaque *et al.* (2017) also observed similar results that dry matter accumulation and LAI

Table 1: Effect of crop residue, FYM and nitrogen on growth parameters of summer moong crop.

Treatment	Germination (%)			Plant height at harvest (cm)			Branches (No.plant^{-1})			Dry weight at harvest (g plant^{-1})		
	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23
Rice residue, FYM and nutrient application to preceding potato												
Rice residue + 125 NPK + 25 t ha^{-1} FYM	95.6 (82.4)	95.3 (82.1)	95.0 (81.9)	52.9	54.7	56.0	8.5	8.7	8.9	16.9	17.1	17.1
Rice residue + 100 NPK + 25 t ha^{-1} FYM	95.3 (82.2)	94.3 (81.3)	93.5 (80.6)	51.6	52.9	55.2	8.3	8.5	8.8	16.6	16.8	16.9
Rice residue + 75 NPK + 25 t ha^{-1} FYM	93.5 (80.6)	93.2 (80.3)	95.2 (82.1)	43.6	44.5	47.3	6.5	6.5	6.7	12.3	13.1	13.9
Rice residue + 125 NPK + 0 t ha^{-1} FYM	92.6 (79.8)	93.0 (80.2)	92.8 (80.0)	42.4	43.1	44.7	6.1	6.2	6.4	10.6	10.9	11.3
Without rice residue + 100 NPK + 50 t ha^{-1} FYM	95.6 (82.4)	93.5 (80.6)	94.2 (81.2)	53.1	55.3	55.0	8.7	8.8	8.7	17.0	17.3	17.0
SE.m (±)	2.5	2.2	1.9	1.3	1.8	1.7	0.5	0.6	0.7	1.4	1.1	0.9
CD (p=0.05)	NS	NS	NS	4.0	5.4	5.2	1.6	1.8	2.0	4.2	3.4	2.8
Nitrogen application in summer moong												
0 N kg ha^{-1}	93.0 (80.2)	92.3 (79.6)	92.7 (79.9)	47.0	48.1	49.6	6.9	7.3	7.2	13.9	14.3	14.3
6.25 N kg ha^{-1}	94.1 (81.1)	94.3 (81.3)	94.5 (81.5)	48.6	50.1	51.7	7.7	7.8	7.9	14.6	15.0	15.2
12.5 N kg ha^{-1}	96.5 (83.2)	95.0 (81.9)	95.2 (82.1)	50.6	52.1	53.5	8.3	8.4	8.6	15.5	15.8	16.3
SE.m (±)	1.9	2.1	1.5	1.1	1.3	1.1	0.5	0.3	0.4	0.6	0.5	0.6
CD (p=0.05)	NS	NS	NS	3.2	3.8	3.2	1.4	1.0	1.3	1.8	1.5	1.8
Interaction	NS	NS	NS	2.8	3.8	2.3	1.2	0.9	0.7	1.2	1.5	1.2

Figures in parentheses are arcsine transformed value.

Table 2: Effect of crop residue, FYM and fertilizers on growth parameters of summer moong crop.

Treatment	LAI			Chlorophyll content index			Day to 50% flowering			Days to maturity		
	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23
Rice residue, FYM and nutrient application to preceding potato												
Rice residue + 125 NPK + 25 t ha^{-1} FYM	2.33	2.37	2.39	28.3	28.8	29.1	40	42	45	76	75	74
Rice residue + 100 NPK + 25 t ha^{-1} FYM	2.31	2.36	2.36	27.8	28.4	28.6	38	42	44	74	75	72
Rice residue + 75 NPK + 25 t ha^{-1} FYM	2.09	2.11	2.12	22.9	24.3	25.6	38	38	42	72	72	72
Rice residue + 125 NPK + 0 t ha^{-1} FYM	1.77	1.80	1.82	20.6	22.3	23.6	37	38	40	68	70	70
Without rice residue + 100 NPK+ 50 t ha^{-1} FYM	2.35	2.38	2.37	28.4	28.9	28.4	39	40	40	70	74	70
SE.m (±)	0.1	0.1	0.1	1.3	1.2	1.0	1.4	1.8	1.8	1.5	1.5	1.4
CD (p=0.05)	0.18	0.24	0.20	4.0	3.7	3.0	NS	NS	NS	NS	NS	NS
Nitrogen application in summer moong												
0 N kg ha^{-1}	2.11	2.14	2.15	24.3	25.1	25.5	38	38	40	70	71	70
6.25 N kg ha^{-1}	2.18	2.20	2.20	25.5	26.4	27.1	39	40	38	73	74	72
12.5 N kg ha^{-1}	2.23	2.28	2.29	26.9	28.2	28.6	44	42	37	73	75	73
SE.m (±)	0.04	0.03	0.04	0.73	0.99	0.89	1.6	1.4	1.4	1.6	1.6	1.4
CD (p=0.05)	0.12	0.10	0.12	2.2	3.0	2.7	NS	NS	NS	NS	NS	NS
Interaction	0.10	0.08	0.08	2.0	2.5	2.1	NS	NS	NS	NS	NS	NS

increased with increasing nitrogen upto 60 kgha^{-1} N. As N is constituent of enzyme and nucleic acids, it is essential for the development of new cells particularly under N deficient soil. Thus one of the obvious manifestations of N limitation is in the inhibition of leaf area development under low N environment (Sinclair and Vandez, 2002). The days t o 50% flowering and days to maturity were non-significantly affected by both the factors as per the data of three years (Table 2).

Yield attributing characters

The pod length, number of pod, number of seed and 1000 -seed wt. was significantly affected with the treatments applied to preceding potato crop (Table 3). The application of rice residue + 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher pod length, number of pod, number of seed and 1000-seed wt. of summer moong crop as compared to rice residue+ 75% NPK + 25 t ha^{-1} FYM and rice residue+ 125% NPK + 0 t ha^{-1} FYM while at par to rice residue+ 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100% NPK 50 t ha^{-1} FYM as per the data of three years. Organic matter acts as a reservoir of plant nutrients, chiefly N, P and S and it improves cation exchange capacity of soil (Brady and Weil, 2012), thus increased the nutrients availability and uptake to crop. Therefore increased nutrients availability and uptake results increased yield attributing characters of summer moong. (Sharma *et al.,* 2023) also reported that the integrated use of FYM and residue along with chemical fertilizers in preceding maize and wheat crop had significantly higher carry-over effect on succeeding moong with respect to growth, yield attributes and productivity. The maximum yield attributing characters *viz.* pod length, number of pod, number of seed and 1000-seed wt. was observed with 12.5 kg ha^{-1} N which was significantly higher than the 0 and 6.25 5 kg ha^{-1} N as per the pooled data of three years. Razzaque *et al.* (2017) also observed similar results that yield and yield attributing character increased with increase in nitrogen upto 60 kg ha^{-1}.

Yield

The seed, stover and biological yield were significantly affected with the treatments applied to preceding potato crop (Table 4). The application of rice residue + 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher seed, stover and biological yield of summer moong crop as compared to rice residue+ 75% NPK + 25 t ha^{-1} FYM and rice residue + 125% NPK + 0 t ha^{-1} FYM while at par to rice residue + 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100% NPK 50 t ha^{-1} FYM during the three years of experimentation. Organic matter acts as a reservoir of plant nutrients, chiefly N, P and S and it improves cation exchange capacity of soil (Brady and Weil, 2012), thus increased the nutrients availability and uptake to crop. Therefore increased nutrients availability and uptake results increased yield and yield attributing characters of summer moong. Sharma *et al.* (2023) also reported that the integrated use of FYM and residue along with chemical

Table 3: Effect of crop residue, FYM and fertilizers on yield attributes of summer moong crop.

Treatment	Number of pod (No. plant^{-1})			Pod length (cm)			Number of seed (No. pod^{-1})			1000-seed wt.(g)		
	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23
Rice residue, FYM and nutrient application to preceding potato												
Rice residue + 125 NPK + 25 t ha^{-1} FYM	27.3	27.6	27.7	9.2	9.3	9.4	10.8	10.9	11.1	37.1	38.3	39.1
Rice residue + 100 NPK + 25 t ha^{-1} FYM	26.7	27.1	27.2	9.0	9.2	9.3	10.7	10.8	10.9	37.1	38.1	38.5
Rice residue + 75 NPK + 25 t ha^{-1} FYM	20.5	21.1	21.4	7.8	8.1	7.9	9.2	9.6	9.6	36.2	36.6	36.8
Rice residue + 125 NPK + 0 t ha^{-1} FYM	20.0	20.9	21.6	7.8	7.8	7.6	8.0	8.1	8.2	35.5	35.9	36.2
Without rice residue + 100 NPK+ 50 t ha^{-1} FYM	27.6	28.3	28.5	9.3	9.4	9.4	10.9	11.0	10.9	37.3	38.3	38.8
SE.m (±)	1.9	1.6	1.8	0.4	0.3	0.4	0.5	0.3	0.4	0.3	0.5	0.5
CD (p=0.05)	5.8	4.8	5.4	1.2	1.0	1.2	1.4	1.0	1.3	0.8	1.4	1.6
Nitrogen application in summer moong												
0 N kg ha^{-1}	22.8	23.4	23.8	8.1	8.2	8.3	9.3	9.4	9.4	36.4	37.1	37.4
6.25 N kg ha^{-1}	24.3	25.0	25.1	8.5	8.7	8.7	9.9	10.0	10.1	36.7	37.4	37.9
12.5 N kg ha^{-1}	26.1	26.7	26.8	9.2	9.3	9.1	10.5	10.7	10.9	36.9	37.8	38.3
SE.m (±)	1.9	0.9	0.7	0.3	0.3	0.3	0.3	0.2	0.4	0.2	0.2	0.3
CD (p=0.05)	3.0	2.7	2.1	1.0	0.8	0.8	1.0	0.5	1.3	0.5	0.6	0.8
Interaction	1.3	1.1	0.8	0.8	0.6	0.6	0.8	1.0	1.2	0.5	0.5	0.7

Table 4: Effect of crop residue, FYM and fertilizers on yield of summer moong crop.

Treatment	Grain yield (kg ha^{-1})			Stover yield (kg ha^{-1})			Biological yield (kg ha^{-1})			Harvest index (%)		
	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23
Rice residue, FYM and nutrient application to preceding potato												
Rice residue + 125 NPK + 25 t ha^{-1} FYM	1342.4	1355.4	1468.8	2731.9	2803.2	2860.1	4074.3	4158.7	4328.9	32.9	32.6	33.9
Rice residue + 100 NPK + 25 t ha^{-1} FYM	1328.4	1350.3	1463.2	2671.8	2701.8	2808.1	4000.2	4052.1	4271.2	33.2	33.3	34.3
Rice residue + 75 NPK + 25 t ha^{-1} FYM	1065.2	1099.8	1119.6	2338.1	2439.1	2564.5	3403.3	3538.9	3684.1	31.3	31.1	30.3
Rice residue + 125 NPK + 0 t ha^{-1} FYM	925.6	945.6	967.5	2103.3	2179.3	2240.7	3029.0	3124.8	3208.2	30.6	30.2	30.2
Without rice residue + 100 NPK+ 50 t ha^{-1} FYM	1354.1	1381.8	1444.5	2767.7	2810.9	2845.7	4121.7	4192.6	4290.2	32.8	33.0	33.7
SE.m (±)	81.0	72.8	102.2	103.0	71.9	74.0	165.1	138.6	151.8	0.5	0.5	1.1
CD (p=0.05)	245.7	220.8	310.2	312.4	218	224.6	500.8	420.4	460.7	1.6	1.4	3.2
Nitrogen application in summer moong												
0 N kg ha^{-1}	1130.0	1149.6	1215.2	2389.2	2480.5	2539.5	3519.2	3630.1	3754.7	32.0	31.5	32.1
6.25 N kg ha^{-1}	1209.3	1225.5	1294.8	2528.2	2581.2	2653.9	3737.5	3806.7	3948.7	32.2	32.1	32.6
12.5 N kg ha^{-1}	1270.1	1304.6	1368.2	2650.4	2698.9	2798.0	3920.4	4003.5	4166.2	32.3	32.5	32.7
SE.m (±)	42.8	48.2	44.5	70.4	64.5	69.4	115.4	122.2	128.5	0.4	0.3	0.5
CD (p=0.05)	130.0	146.2	134.9	213.5	195.7	210.5	350	370.9	390	NS	NS	NS
Interaction	105.6	112.5	120.9	152.6	182.5	201.5	258.6	359.8	312.7	1.5	1.7	2.7

fertilizers in preceding maize and wheat crop had significantly higher carry-over effect on succeeding moong with respect to growth, yield attributes and productivity. The maximum seed, stover and biological yield was observed with 12.5 kg ha^{-1} N which was significantly higher than the 0 and 6.25 5 kg ha^{-1} N as per the data of three years. Razzaque *et al.* (2017) also observed similar results that yield and yield attributing character increased with increase in nitrogen upto 60 kg ha^{-1}. The maximum harvest index was observed with rice residue + 100% NPK + 25 t ha^{-1} FYM which was significantly higher than rice residue + 75% NPK + 25 tha^{-1} FYM and rice residue+ 125% NPK + 0 t ha^{-1} FYM while at par to rice residue+ 125% NPK + 25 t ha^{-1} FYM and without rice residue + 100% NPK 50 t ha^{-1} FYM (Table 4). The application of 12.5 kg ha^{-1} N in summer moong crop resulted higher harvest index as compared to 0 and 6.25 5 kg ha^{-1} N although the difference was non-significant (Table 4).

Quality character

The protein content was non-significantly affected with the treatments applied to preceding potato crop (Table 5). The application of rice residue + 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher protein content as compared to rice residue + 75% NPK + 25 t ha^{-1} FYM and rice residue + 125% NPK + 0 t ha^{-1} FYM while at par to rice residue + 100% NPK + 25 t/ha FYM and without rice residue + 100% NPK 50 t/ha FYM as per the data of three years. The maximum protein content was observed with 12.5 kg ha^{-1} N which was significantly higher than the 0 and 6.25 5 kg ha^{-1} N as per the data of three years.

Nutrients uptake

The nutrient uptakes were significantly affected with the treatments applied to preceding potato crop (Table 5). The application of rice residue+ 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher N, P and K uptake of summer moong crop as compared to rice residue + 75% NPK + 25 t ha^{-1} FYM and rice residue + 125% NPK + 0 t ha^{-1} FYM while at par to rice residue + 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100% NPK 50 t ha^{-1} FYM as per the data of three years. Organic matter acts as a reservoir of plant nutrients, chiefly N, P and S and it improves cation exchange capacity of soil (Brady and Weil, 2012), thus increased the nutrients availability and uptake to crop. Sharma *et al.* (2023) also reported that the integrated use of FYM and residue along with chemical fertilizers in preceding maize and wheat crop had significantly higher carry-over effect on succeeding moong with respect to nutrient uptake. The maximum Nitrogen uptake of summer moong crop was observed with 12.5 kg ha^{-1} N which was significantly higher than the 0 and 6.25 kg ha^{-1} N as per the data of three years. The maximum P and K uptake of summer moong crop was observed with 12.5 kg ha^{-1} N which was at par to 0 and 6.25 kg ha^{-1} N as per the data of three years.

Table 5: Effect of crop residue, FYM and fertilizers on quality and nutrient uptake of summer moong crop.

Treatment	Protein content in grains (%)			Total nitrogen uptake (kg ha^{-1})			Total phosphorus uptake (kg ha^{-1})			Total potassium Uptake (kg ha^{-1})		
	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23	2020-21	2021-22	2022-23
Rice residue, FYM and nutrient application to preceding potato												
Rice residue+ 125 NPK + 25 t ha^{-1} FYM	23.5	23.7	23.8	87.2	89.6	95.7	12.2	13.6	14.6	66.3	68.4	71.7
Rice residue+ 100 NPK + 25 t ha^{-1} FYM	23.0	23.1	23.2	83.3	84.9	90.9	10.9	12.0	13.0	64.2	65.6	69.8
Rice residue+ 75 NPK + 25 t ha^{-1} FYM	22.4	22.5	22.6	66.0	69.3	72.5	7.0	7.4	7.9	49.2	52.2	54.6
Rice residue + 125 NPK + 0 t ha^{-1} FYM	21.7	22.0	22.0	55.4	58.3	60.1	4.8	5.8	6.2	39.3	41.4	42.9
Without rice residue + 100 NPK+ 50 t ha^{-1} FYM	23.6	23.7	23.8	88.9	91.1	93.8	13.1	14.1	13.6	68.1	69.6	70.7
SE.m (±)	0.2	0.1	0.2	3.6	4.9	5.1	1.1	1.4	1.6	4.7	4.3	4.4
CD (p=0.05)	0.5	0.4	0.6	10.8	15.0	15.5	3.2	4.3	4.8	14.2	12.9	13.5
Nitrogen application in summer moong												
0 N kg ha^{-1}	22.5	22.6	22.7	68.6	71.2	74.8	8.6	9.6	10.1	53.7	56.3	58.5
6.25 N kg ha^{-1}	23.0	23.2	23.3	77.5	79.7	84.0	9.8	10.8	11.2	57.8	59.4	61.9
12.5 N kg ha^{-1}	23.1	23.2	23.3	82.3	85.0	89.0	10.4	11.4	11.8	60.8	62.6	65.4
SE.m (±)	0.1	0.1	0.1	2.8	3.2	3.6	1.0	0.8	1.3	3.8	3.0	4.0
CD (p=0.05)	0.3	0.2	0.2	8.6	9.6	10.9	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	8.2	7.0	8.0	3.0	2.4	3.4	12.8	9.8	11.9

CONCLUSION

It is concluded that the application of rice residue + 125% NPK + 25 t ha^{-1} FYM to potato crop resulted significantly higher yield and yield attributing characters of summer as compared to rice residue + 75% NPK + 25 t ha^{-1} FYM and rice residue + 125% NPK + 0 t ha^{-1} FYM while at par to rice residue+ 100% NPK + 25 t ha^{-1} FYM and without rice residue + 100% NPK 50 t ha^{-1} FYM. The application of higher dose of nitrogen @ 12 kg ha^{-1} also significantly increased the yield and yield attributing characters as compared to lower doses of summer moong.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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