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Effect of nutrient management practices on potato based cropping system

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Abstract
A field experiment was conducted during 2017-18 and 2018-19 at ICAR- CPRI-RS, Gwalior M.P. during *kharif and rabi* to judge the "effect of nutrients application on potato based cropping system". The experiment was laid out in split-plot design with three replications. In main plots three cropping systems viz. M_1: Cowpea – Potato, M_2: Maize + Cowpea – Potato, M_3: Maize – Potato with five sub plots of fertility levels viz. F_1: 150% RDF, F_2: 125% RDF, F_3: 100% RDF, F_4: 75% RDF + 25% organic and F_5: 50% RDF + 50% organic replicate three times. At maturity stage, maximum haulm fresh weight and dry weight was found under (150% RDF) which was at par with (75% RDF + 25% N through FYM) followed by (125% RDF) and (100% RDF) recommended doses of fertilizer. Application of 150% RDF (8.34 tubers plant^{-1}) recorded maximum no. of tubers plant^{-1} which was at par with (75 RDF + 25% N through FYM) followed by 125% RDF among all remaining treatments. Maize + Cowpea – potato based cropping system recorded maximum potato equivalent yield of system viz. 46.54, 53.81 and 50.17 t/hectare in the year of 2017-18, 2018-19 and pooled basis, respectively as compare to other cropping systems. Equivalent yield of maize, cowpea were also calculated. Maximum equivalent yield of potato on system (47138.09 kg hectare^{-1} was registered under 150% RDF. This treatment was significantly superior as compare to remaining treatments. Cowpea – potato based cropping system recorded maximum value Per Rs investment ratio and B: C ratio 2.53 and 1.53 on pooled basis, respectively as compare to other cropping systems. Combination of different fertility level had considerable effect on value Per Rs investment ratio and B: C ratio. Maximum ratio 2.47 and 1.47 was registered under 75% RDF + 25% N through FYM.

Keywords: Cowpea, growth, maize, potato equivalent yield and system yield

Introduction
Potato (*Solanum tuberosum* L.) is a carbohydrate-rich, but low fat food crop and herbaceous annual that grow up to 100 cm and contributes substantially towards food and nutritional security in the world which is originated in the high Andean hills of South America.

Potato is an ingredient in many dishes and salads. It is a non-fattening, nutritious and wholesome food that supplies many important nutrients to the diet. It contains approximately 78% water, 22% dry matter (specific gravity) and less than 1% fat. About 82% of dry matter is carbohydrate, mainly starch, with some dietary fiber and have better nutritional quality than cereals. Potato contains at least 12 essential vitamins and minerals and is a source of vitamin c, thiamine, iron and folic acid.

The potato can be distinguished from cereals like rice and wheat for its higher capacity to produce dry matter, which is about 47.6 kg/ hectare/ day. The average raw material composition of a potato tuber is as follows: dry matter (20%), starch (13-16%), total sugars (0-2%), protein (2%), fibre (0.5%), lipids (0.1%), vitamin A (trace/ 100 g fresh weight), vitamin C (31 mg/ 100 g fresh weight), minerals (trace), ash (1-1.5%), amylose (22-25%) and glycoalkaloids (< 1 mg/ 100 g fresh weight) as an ant nutritional factor.

The current global production of potato is around 388.2 million tonnes and China being the biggest producer globally, India ranks 2nd in area and production of potato in the world after China which contribute 11 per cent of world potato production (FAO STAT, 2018). In India potato production is mainly confined to Uttar Pradesh, West Bengal, Madhya Pradesh, Punjab, Assam, Gujarat and Haryana. In India, it is grown on an area of 2.179 million hectares with the production of 48.6 million tonnes (Anonymous, 2017).

Currently, Madhya Pradesh contributes about 05.45 per cent in area and 05.24 per cent in production of potato in the country. The area under the crop during 2013-14 was 109.96 thousand hectares and the production was 3144.00 thousand tonnes in M.P. During 2017, productivity of Gujarat was (29750 kg/ha) highest in India and Madhya Pradesh was at 6th position with 21116 kg/ha yield (Agricultural Statistics at a Glance, 2018) [2].

Cowpea-potato, Maize + cowpea – potato, Maize – potato cropping system is an important system and are being practiced to generate income and produce more food per unit of land to meet the rapidly growing population. Nutrient management on cropping system basis is more efficient and judicious than sole crop basis, because the residual effects of fertilizer applied to one crop are exploited by the succeeding crop. (Singh and Kushwah, 2006) [10].

Cowpea is used as intercrop with maize because, cowpea is one of the most important leguminous vegetable crop and has unique ability of biological nitrogen fixation, deep root system, mobilization of insoluble soil nutrient and bringing qualitative changes in soil. Vegetable cowpea (*Vigna unguiculata* L. Walp), belongs to the family leguminoceae, originated from Central Africa. Vegetable cowpea either utilized for green pods as vegetable or green manuring forms an important component of farming systems from the arid to the humid tropics covering parts of Asia and Oceania, the Middle East, Southern Europe, Africa, Central and South America. It is an annual legume adapted to warm conditions and sensitive to chilling hence, it is cultivated widely in tropics and subtropics during the warm season. Pulses are important source of dietary protein and have unique ability of maintaining and restoring soil fertility through biological nitrogen fixation as well as addition of ample amount of residues to the soil. Pulse crops leave behind reasonable quantity of nitrogen in soil to the extent of 30 kg/ha. Green tender pods contain moisture (84.6%), protein (4.3%), carbohydrate (8.0%), fats (0.2%) and rich source of calcium, phosphorus, iron, etc. The dose of fertilizer depends on the initial soil fertility status and moisture conditions. Although cowpea being a legume is capable of fixing atmospheric nitrogen, it responds to small quantity of nitrogenous fertilizers applied as starter dose. Application of 15-20 kg N/ha has been found optimum to get better response. Application of higher dose of nitrogen may reduce nodule number and growth and thus adversely affects the nitrogen fixation capacity. In terms of significance, phosphorus is most indispensable mineral nutrient for pulse crops as it helps in better root growth and development and thereby making them more efficient in biological nitrogen fixation (BNF). Indian soils are characterized poor to medium status with respect to nitrogen and available phosphorus. Integrated efforts are required to boost up the yield of cowpea in order to supply a balanced diet to increasing population of our country. In India, the average productivity of our countries (465 Kg/ha) which was less than world average (1691 kg/ha). Cowpea grain contains about 22% protein and constitutes a major source of protein for resource-poor rural and urban people.

Therefore, there is need to optimize nutrient requirement in potato based cropping system through organic and inorganic sources. Several studies have been conducted and recommendations have been made for fertilizer requirement of individual crop, but fertilizer recommendations for intercropping systems are very much limited as it depends upon population and yield potential of the component crops in intercropping system. Fertilization in legume crops is important at initial stages. Nutrients in soil solution are replenished either by desorption from soil surface, mineralization of soil organic matter or by addition of fertilizers. Fertilizer application is one of major production input recognized in any crop-production system (Rana *et al*., 2001) [8]. Considering the above fact an experiment was conducted in maize to judge the "effect of nutrients application on potato based cropping system"

Materials and Methods

The present investigation on "Effect of nutrient management practices on growth and yield of potato (*Solanum tuberosum* L.) based cropping systems" was carried out at ICAR-CPRI-RS, Gwalior (M.P.) during *kharif* and the following *rabi* season of 2017-18 and 2018-19. The experimental soil was silty clay loam soil in texture, neutral in reaction (pH 6.84), low in organic C (0.47%), and available N (180.30 kg/ha), medium in available P (13.15 kg/ha) and high in available K (270.55 kg/ha). The experiment was laid out in split-plot design with three replications. Planting pattern were assigned to main plots and fertility level practices in sub plots. In main plots three cropping systems viz. M_1: Cowpea – Potato, M_2: Maize + Cowpea – Potato, M_3: Maize – Potato with five sub plots of fertility levels viz. F_1: 150% RDF, F_2: 125% RDF, F_3: 100% RDF, F_4: 75% RDF + 25% organic and F_5: 50% RDF + 50% organic replicate three times.

The gross plot size of the one plot was 4.8 m × 4.0 m. Maize hybrid variety 'MRM-3777' and cowpea variety 'Ankur' was sown during *kharif* and potato 'Kufri chandramukhi' during *rabi* with a seed rate of 20 kg, 25 kg and 30 q/ha, respectively and a recommended fertilizer dose of 120:60:40 kg N : P_2O_5 : K_2O kg/ha, respectively for maize and cowpea 18:46:0 kg N : P_2O_5 : K_2O kg/ha and 180:80:120 kg N : P_2O_5 : K_2O kg/ha, respectively potato crop. The sowing of maize and cowpea in sole as main crop and cowpea used as intercrop in main crop maize in additive series. Maize, cowpea and potato at spacing of 60 cm from row to row and 20 cm from plant to plant with manually.

Five potato plants were randomly sampled from the inner rows of the each plot leaving the border rows. The sampled plants were carefully dunged up, the roots thoroughly washed under running water, put in labeled envelop bags and taken to the laboratory where the growth parameters were recorded at 30, 60 DAP and maturity stage. Equivalent yield of potato based system was calculated in terms of potato equivalent yield (PEY) by using following formula:

$$\text{PEY of maize} = \frac{\text{Maize yield}}{\text{Potato price}} \times \text{Maize price}$$

$$\text{PEY of Cowpea} = \frac{\text{Cowpea yield}}{\text{Potato price}} \times \text{Cowpea price}$$

$$\text{System equivalent yield} = \frac{\text{Potato yield}}{\text{Potato price}} \times \text{Potato Price} + \text{PEY of potato} + \text{PEY of Cowpea}$$

Results and Discussion

Fresh haulm weight/plant

Overall, fresh potato haulm weight increased with the advancement in crop age and reached maximum at 60 DAP (Table1). The maximum significant haulm fresh weight at 30 DAP was found under cowpea-potato based cropping system 51.09 g plant^{-1} during 2017-18, respectively followed by Maize + cowpea – Potato based cropping system. At 60 DAP, Maize + cowpea – Potato based cropping system recorded maxim haulm fresh weight under 150% RDF. While, maximum haulm fresh weight at maturity stage was found under (150% RDF) which was at par with (75% RDF + 25% N through FYM) followed by (125% RDF) and (100% RDF) recommended doses of fertilizer. The effect of various treatments with respect to plant fresh haulm weight was found significant at all the stages of crop growth (164.04 g/plant during 2018-19) respectively, in cowpea – potato based

cropping system, except 2018-19 at 60 DAP stage during both the years. It may be due to supply of efficient and balanced amount of nutrients at different stages and increasing the availability of nutrient to the plant.

Initial slow growth of plant, primarily due to lower assimilating surface leading to lower rate of photosynthesis while adequate and balanced fertilization promoted the plant growth parameters viz. plant height, number of leaf and photosynthetic activity and ultimately produced higher fresh haulm weight/plant at later stages upto 60 DAP.

Table 1: Effect of nutrient management practices on haulm fresh weight per plant of potato under potato based cropping system on pooled basis

Treatment	Haulm fresh weight per plant					
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
	30 DAP		60 DAP		Maturity	
Main plot						
M_1:Cow pea –potato	51.09	44.36	180.27	147.82	164.04	189.60
M_2:Maize + cowpea – Potato	38.15	46.17	190.48	166.65	178.57	159.23
M_3:Maize- Potato	33.85	43.83	170.71	172.12	171.41	139.87
S.E.(m)±	0.58	0.65	3.94	2.34	2.29	2.93
C.D. (at 5%)	2.27	NS	NS	9.19	7.47	NS
Sub plot						
S_1:150% RDF	44.00	42.57	207.02	171.04	189.03	168.58
S_2:125% RDF	42.89	39.49	173.91	169.54	171.73	167.11
S_3:100% RDF	40.58	53.06	173.38	159.78	166.58	145.47
S_4: 75% RDF + 25% N through FYM	40.82	43.93	175.44	169.58	172.51	167.47
S_5: 50% RDF + 50% N through FYM	36.87	44.89	172.67	141.04	156.86	165.87
S.E.(m)±	0.80	1.52	4.98	8.06	4.74	3.23
C.D. (at 5%)	2.33	4.43	14.53	NS	13.39	9.42
Interaction	SIG	SIG	SIG	SIG	SIG	SIG

Dry weight per plant (DWP/plant)

At all growth stages, cowpea-potato based cropping system resulted in haulm dry weight of crop growth and it was significantly superior over Maize + cowpea - Potato and Maize - Potato cropping system at all the stages of crop growth.

At all crop growth stages, 150% RDF recorded maximum plant dry weight plant^{-1}. The dry matter production/plant by different nutrient application treatments improved with the advancement in the growth stages till the maturity stage (Table 2). Rapid rate of growth was during the period between 30 DAP to 60 DAP. The rate of increase in DMP/plant was very slow at early growth stage (30 DAP) in all the treatments. Similarly, the same time accumulated photosynthates and food materials were utilized for the development of tuber up to maturity so the tuber DM production was also increase during 60 DAP to maturity stage but less than from 30 to 60 DAP.

Table 2: Effect of nutrient management practices on plant dry weight (g) of potato under potato based cropping system on pooled basis

Treatment	plant dry weight (g)					
	30 DAP		60 DAP		Maturity	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
Main plot						
M_1:Cow pea –potato	3.49	2.96	18.10	11.10	26.39	19.13
M_2:Maize + cowpea – Potato	2.52	2.82	18.16	13.09	23.25	21.17
M_3:Maize- Potato	1.85	2.57	15.43	14.05	19.23	21.44
S.E.(m)±	0.07	0.16	0.47	0.39	0.32	0.25
C.D. (at 5%)	0.26	NS	1.84	1.52	1.24	0.99
Sub plot						
S_1:150% RDF	2.85	2.79	21.71	14.62	24.71	19.59
S_2:125% RDF	2.57	2.46	15.51	13.45	22.82	20.63
S_3:100% RDF	2.47	3.30	16.55	13.10	21.76	20.54
S_4: 75% RDF + 25% N through FYM	2.82	2.59	15.81	12.51	23.91	21.37
S_5: 50% RDF + 50% N through FYM	2.38	2.79	16.57	10.06	21.58	20.77
S.E.(m)±	0.08	0.16	0.54	0.67	0.61	0.47
C.D. (at 5%)	0.22	0.47	1.56	1.96	1.79	NS
Interaction	SIG	SIG	SIG	SIG	SIG	SIG

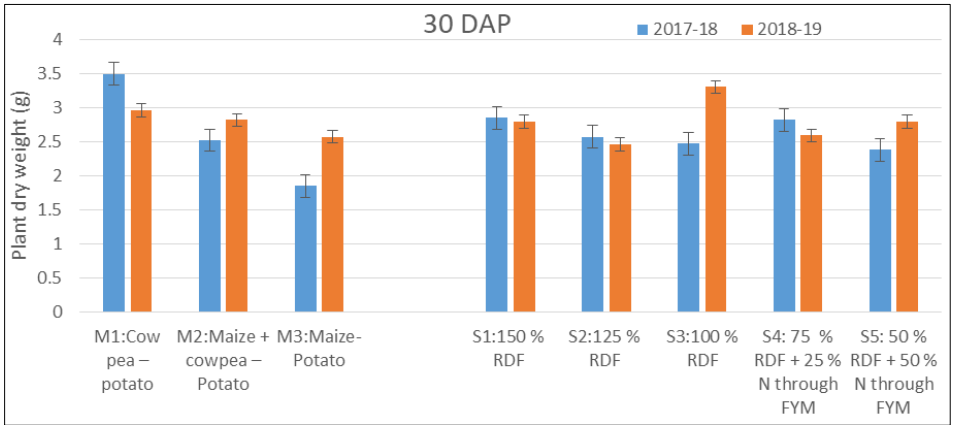

Fig 1: Plant dry weight as influenced by nutrient management practices under potato based cropping system at 30 DAP

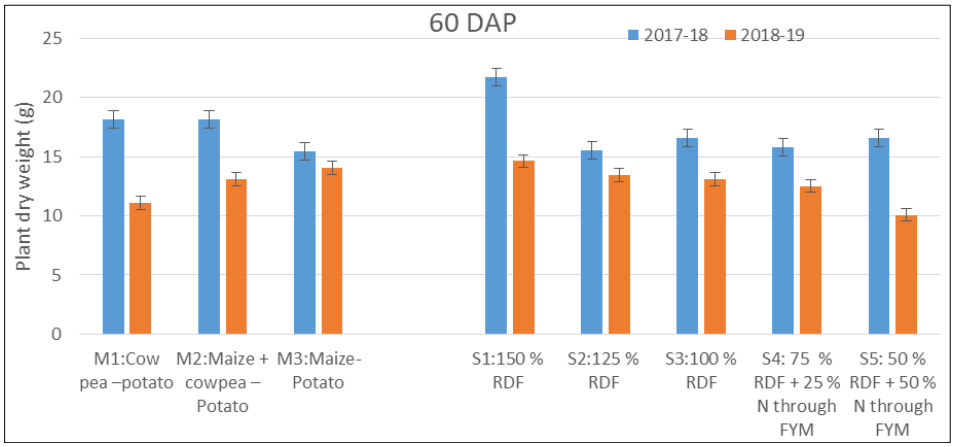

Fig 2: Plant dry weight as influenced by nutrient management practices under potato based cropping system at 60 DAP

Fig 3: Plant dry weight as influenced by nutrient management practices under potato based cropping system at maturity stage

Number of tuber/plant

The effect of various cropping systems with respect to tuber number of potato was found significant at all the stages of crop growth during both the years, except 60 DAP at which no significant result of no. of tubers plant^{-1} was found during both the years (Table 3). Different cropping systems and fertility levels stimulated tuberization at early stage of crop growth. This may be due to positive effect of nutrient on tuberization. When different cropping systems were compared, at growth stages cowpea-potato based cropping system resulted in maximum no. of tubers at all stages of crop growth and it was significantly superior over Maize + cowpea - Potato and Maize – Potato cropping system.

At maturity stage, 150% RDF on pooled basis recorded maximum no. of tubers plant^{1} which was at par with (75 RDF + 25% N through FYM) followed by 125% RDF among all remaining treatments. Lowest value of no. of tubers plant^{-1} was recorded with (50% RDF + 50% N through FYM) on pooled basis respectively. This may be due to higher and balanced availability of essential nutrient to crop plant owing to reduce the losses of applied nutrient through FYM. FYM also supply beneficial growth regulator to crop plant as a result incensement in physiological process within the plant ultimately higher tuber number/plant. This result also supported by Ahmed *et al.* (2015) [1], Meena *et al.* (2013) [6], Mohammed *et al.* (2018) [5], Narayan *et al.* (2013) [7] and Singh *et al.* (2018) [11].

Table 3: Effect of nutrient management practices on no. of tuber per plant of potato under potato based cropping system on pooled basis

Treatment	No. of tuber per plant					
	30 DAP		60 DAP		Maturity	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
Main plot						
M_1:Cow pea –potato	3.64	2.41	7.19	5.82	10.53	7.53
M_2:Maize + cowpea – Potato	2.52	1.93	6.92	5.93	9.11	7.45
M_3:Maize- Potato	2.48	2.09	6.84	5.32	5.81	7.08
S.E.(m)±	0.11	0.04	0.10	0.19	0.19	0.16
C.D. (at 5%)	0.41	0.14	NS	NS	0.73	NS
Sub plot						
S_1:150% RDF	3.36	2.02	7.46	6.52	8.93	7.76
S_2:125% RDF	2.91	2.04	7.20	5.66	8.47	7.47
S_3:100% RDF	2.58	2.27	6.47	5.31	8.07	7.22
S_4: 75% RDF + 25% N through FYM	2.91	2.26	7.31	5.69	8.89	7.69
S_5: 50% RDF + 50% N through FYM	2.64	2.11	6.49	5.27	8.07	6.64
S.E.(m)±	0.14	0.10	0.18	0.19	0.30	0.26
C.D. (at 5%)	0.42	NS	0.52	0.55	NS	0.75
Interaction	SIG	SIG	SIG	SIG	SIG	SIG

Potato equivalent yield of maize

Different fertility levels lead to increase in potato equivalent yield in sole maize, maximum potato equivalent yield in was found under 150% RDF 12094.91 15989.97 during 2017-18, respectively, similarly in inter maize maximum potato equivalent yield 10720.49 and 14822.53 during 2017-18, respectively as shown in table no. 4.

Table 4: Effect of nutrient management practices on maize equivalent yield of potato on pooled basis

Treatment	PE maize grain yield kg/ha	
	2017-18	2018-19
	Sole Maize	
SM_1:150% RDF	12094.91	15989.97
SM_2:125% RDF	11792.53	15380.02
SM_3:100% RDF	11545.14	14579.86
SM_4:75% RDF NPK +25% N through FYM	11600.12	15466.59
SM_5:50% RDF NPK + 50% N through FYM	10489.58	12704.09
	Intercrop maize	
IM_1:150% RDF	10720.49	14822.53
IM_2: 125% RDF	9675.93	14094.52
IM_3:100% RDF	9346.06	13596.06
IM_4:75% RDF NPK +25% N through FYM	9950.81	14566.74
IM_5:50% RDF NPK + 50% N through FYM	8741.32	11648.15

Potato equivalent yield of cowpea

Different fertility levels lead to increase in potato equivalent yield in sole cowpea, maximum potato equivalent yield in was found under 150% RDF 12094.91 and 15989.97 kg/hectare during 2017-18 and 2018-19, respectively, similarly in inter maize maximum potato equivalent yield 10720.49 and 14822.53 kg/hectare during 2017-18 and 2018-19 respectively as shown in table no. 5.

Table 5: Effect of nutrient management practices on cowpea equivalent yield of potato under potato based cropping system on pooled basis

Treatment	PE cowpea grain yield kg/ha	
	2017-18	2018-19
	Sole cowpea	
SC_1:150% RDF	9385.34	10711.65
SC_2:125% RDF	8678.55	8990.82
SC_3:100% RDF	8391.74	8510.42
SC_4:75% RDF NPK +25% N through FYM	11382.95	11604.55
SC_5:50% RDF NPK + 50% N through FYM	7681.48	8068.67
	Intercrop cowpea	
IC_1:150% RDF	7752.39	7877.55
IC_2: 125% RDF	7400.54	7284.26
IC_3:100% RDF	6975.00	6971.22
IC_4:75% RDF NPK +25% N through FYM	7560.03	7807.18
IC_5:50% RDF NPK + 50% N through FYM	5692.90	5690.59

Equivalent yield of system

Maize + Cowpea – potato based cropping system recorded maximum potato equivalent yield viz. 46540.13, 53813.91 kg/hectare in the year of 2017-18, 2018-19, respectively as compare to other cropping systems (Table 6). Intercrop productivity was evaluated equivalent yield (Bandhopadhyay, 1984) [3].

Combination of different fertility level had considerable effect on potato equivalent yield of system. Maximum potato equivalent yield (47138.09 kg/ha) on pooled basis was registered under 150% RDF. This fertility level was significantly superior as compare to remaining. While, it was at par with75% RDF + 25% N through FYM followed by 125% RDF in 2017-18. However, higher yield was observed in the system where maize intercrop with cowpea was included in succeeding year. However, more variation was recorded in the productivity of the potato during first year and second year. However, the mean data of two years of experimentation revealed that the productivity of Maize + cowpea – Potato was the highest followed by the Cowpea – Potato.

This results is also in conformity with the finding of Singh *et al.* (2006). The lowest productivity was recorded in maize crop. The lowest system productivity was obtained under potato-maize cropping system. Similar findings found by Yadav *et al.* 2015.

Table 6: Effect of nutrient management practices on potato equivalent yield of system and economics under potato based cropping system on pooled basis

	Potato equivalent of system kg/ha	
Main plot	**2017-18**	**2018-19**
M_1:Cow pea – Potato	39538.13	44139.36
M_2:Maize + cowpea – Potato	46540.13	53813.91
M_3:Maize- Potato	35359.05	44199.62
S.E.(m)±	563.68	478.81
C.D. (at 5%)	2212.93	1879.75
Sub plot		
S_1: 150% RDF	43278.45	50997.74
S_2: 125% RDF	40930.89	48958.15
S_3:100% RDF	39522.20	46112.62
S_4: 75% RDF + 25% N through FYM	41804.99	49284.11
S_5: 50% RDF + 50% N through FYM	36859.00	41568.85
S.E.(m)±	814.05	712.13
C.D. (at 5%)	2376.16	2078.67
Interaction	NS	SIG

Table 7: Effect of nutrient management practices on potato equivalent yield of system and economics under potato based cropping system on pooled basis

Treatment	**Economics of potato**			
	Gross income (Rs/hectare)	**Net Income Rs/hectare**	**Per Rs investment ratio**	**B: C ratio**
Main plot				
M_1:Cow pea – Potato	194988.76	117999.46	2.53	1.53
M_2:Maize + cowpea – Potato	185890.44	108901.14	2.41	1.41
M_3:Maize- Potato	166111.31	89122.00	2.16	1.16
S.E.(m)±	2056.14	2056.14	0.03	0.03
C.D. (at 5%)	6705.45	6705.45	0.09	0.09
Sub plot				
S_1: 150% RDF	194343.68	112467.75	2.37	1.37
S_2: 125% RDF	188187.50	108757.65	2.37	1.37
S_3:100% RDF	178682.31	101698.48	2.32	1.32
S_4: 75% RDF + 25% N through FYM	184367.92	109821.09	2.47	1.47
S_5: 50% RDF + 50% N through FYM	166069.44	93959.36	2.30	1.30
S.E.(m)±	3079.01	3079.01	0.04	0.04
C.D. (at 5%)	8698.88	8698.88	0.11	0.11
Interaction	NS	NS	NS	NS

Economics of treatments

The economics of treatment has much concern for farmer's point of view. The determination of economic valuation of treatments was made under four important heads viz. gross income, net income, B: C ratio and return per rupee invested. The above mentioned economic factors were estimated on per hectare area basis by considering the existing market values of different inputs and outputs which was depicted on table no. 7.

Cowpea – potato based cropping system recorded maximum gross income 195085.99 Rs./hectare on pooled basis, respectively as compare to other cropping systems. Maximum gross income 194343.72 Rs./hectare was registered under 150% RDF. This treatment was significantly superior as compare to remaining treatments at pooled basis. This is due to higher economical under this treatment. Lowest gross income recorded under maize-potato based cropping system 166111.31 Rs./hectare pooled basis, respectively. This is due to minimum economical yield under this treatment**.** This result also lined with the findings of Sarkar *et al.* (2011) [9], Yadav *et al.* (2017) [13] and Kumar *et al.* (2007).

The net income is the actual monetary profit of a particular treatment, because it is determined by subtracting the total cost of cultivation of a treatment from the gross income of the same treatment. Cowpea – potato based cropping system recorded maximum net income 117999.46 Rs./hectare on pooled basis, respectively as compare to other cropping systems. Maximum net income (Rs. 112467.75) was registered under 150% RDF. This treatment was significantly superior as compare to remaining treatments at pooled basis. This findings also supported by Sarkar *et al.* (2011) [9], Yadav *et al.* (2017) [13] and Kumar *et al.* (2007).

Cowpea – potato based cropping system recorded maximum value Per Rs investment ratio and B: C ratio 2.53 and 1.53 on pooled basis, respectively as compare to other cropping systems. While, maximum B: C ratio and return per rupee invested recorded with75% RDF NPK +25% N through FYM during in 2017-18 and pooled basis. This is due to proportionally less total cost of cultivation as compare to net and gross income in respect to B: C ratio and return per rupee invested, respectively. This findings supported by Sarkar *et al.* (2011) [9], Yadav *et al.* (2017) [13] and Kumar *et al.* (2007).

Summary and Conclusion

From the farmer point of view economics is the main concern, Maize + Cowpea – Potato based cropping system recorded maximum potato equivalent yield of sytem in the year of 2018-19 respectively, as compare to other cropping systems with application of 150% RDF, at par with 75% NPK + 25% N through FYM. maximum B: C ratio and return per rupee invested during both the years and pooled basis. Whereas, in case of gross and net income, Cowpea-potato based cropping system recorded maximum income with 150% RDF, but 75% RDF NPK + 25% N through FYM gave maximum B : C ratio and return per rupee invested which is at par with 150% RDF followed by 125% RDF. Therefore, obtaining higher benefit in cowpea-potato cropping system, application of 75% RDF NPK + 25% N through FYM was found best from all levels.

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