

## Performance of Nutrient Management in Potato Preceding by Green Manuring Crops

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**ABSTRACT:** The present investigation was conducted at Department of Agronomy, Mahatma Phule Krishi Vidyapeeth Rahuri, Ahmednagar, Maharashtra to study the performance of nutrient management in potato preceding by green manuring crops for two consecutive years during 2013- 2014 and 2014- 2015. The soil of experimental field was sandy clay loam in texture with low in available nitrogen ( $168.33 \text{ kg ha}^{-1}$ ), medium in available phosphorus ( $22.43 \text{ kg ha}^{-1}$ ) and high ( $361.30 \text{ kg ha}^{-1}$ ) in available potash. The experiment was carried out in split-plot design with three replication. The incorporation of dhaincha at 50 % flowering stage as a green manuring crop in kharif season followed by growing of potato in rabi season with 100% general recommended dose of fertilizers ( $\text{GRDF-120:60:120 N P}_2\text{O}_5 \text{ K}_2\text{O kg ha}^{-1}$  + 20 tons of farm yard manure  $\text{ha}^{-1}$ ) found superior for recording maximum potato tuber yield ( $35.03, 38.61$  and  $35.81 \text{ t ha}^{-1}$ ) in 2013-14, 2014-15 and pooled data.

**Key Words:** Green manuring crops, potato, nutrient management, biomass, quality and yield

### INTRODUCTION

Potato (*Solanum tuberosum* L) is one of the most important vegetable crops after wheat, maize and rice, contributing to food and nutritional security in the world. This tuber crop of the family solanaceae has about 200 wild species. It originated in the high Andean hills of South America, from where it was first introduced into Europe towards the end of 16<sup>th</sup> century through Spanish conquerors. It was introduced to India by early 17<sup>th</sup> century probably through British missionaries or Portuguese traders (Anonymous, 2014a and b). Potato was officially dubbed the “food of the future” as the recently concluded flagship event of the United Nation’s International year of Potato in Peru.

Green manure crop can play an important role in the soil fertility improvement, when incorporated into the soil, improves soil organic matter, moisture retention capacity and soil workability (Kiiya *et al.* 2010). Incorporation of green manure in soil increases the bioavailability of phosphate in succeeding crop (Khan *et al.* 2010). Fertilization and manuring plays a crucial role in potato production. Combined use of organic fertilizers with inorganic sources improves the productivity and giving higher returns per unit area per unit time (Chetri *et al.* 2002).

Potato producers are using green manures to produce better crops by improving the quality of their soils. The physical, biological, and some chemical characteristics of soil may be improved by green manures. Physical characteristics such as water infiltration rate, tilth, water holding capacity and aeration, are generally improved by the addition of organic matter to the soil, with the help of green manure, compost, or crop residues. This can lead to the growth of larger, healthier root systems which help plants better handle stress. The chemical properties of a soil can be improved by increasing nutrient and organic matter levels. This too comes from organic amendments to the soil. The biological characteristics of a soil, such as biomass, biological activity, and biodiversity, can also be improved through green manures. These changes in the soil’s biology provide the short term economic incentive to use green manure crops in potato cropping systems, especially for soil borne pest management, fungal and bacterial diseases, nematodes, and weeds can all be reduced by using a green manure crop. However, the degree and duration of these beneficial effects depend on many factors, such as soil texture, climate, tillage practices, and crop rotation. Therefore, the benefits of green manures may differ between systems (Andy Mc Guire, 2003).

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Keeping in view the above finding and importance of the Performance of nutrient management in potato preceding by green manuring crops a research work was carried out to 1.To study the performance of nutrients management in potato preceded by green manuring crops. 2.To study the effect of nutrients management on growth, yield and quality of potato.

## MATERIALS AND METHODS

The field experiment was conducted for two consecutive years at Post Graduate Institute Research Farm of Mahatma Phule Krishi Vidyapeeth Rahuri during 2013- 2014 and 2014- 2015. It lies between 19° 48' N and 19° 57' N latitude and 74° 19' E and 74° 32' E longitude. The altitude varies from 495 to 569 meters above mean sea level. Climatologically, this area falls in the semi-arid tropics with annual rainfall ranged from 307-619 mm. the average annual precipitation is 520 mm. Out of total annual rainfall, about 80 per cent rains received from south-west monsoon (June-September). While, the rest received from North-East Monsoon (October-November). The rainfall is erratic and ill distributed in 15-45 rainy days in different year. The tract is in the shadow area, lying on eastern side of western ghat.

A soil sample was collected from the experimental field at the beginning of the experiment and physical and chemical properties were determined. It is observed that the soil of experimental site was sandy clay loam in texture. The chemical composition according to criteria laid by Muhr *et al.* (1965) indicated that soil was low in available nitrogen (168.33 kg ha<sup>-1</sup>), medium in available phosphorus (22.43 kg ha<sup>-1</sup>) and high (361.30 kg ha<sup>-1</sup>) in available potash. The soil was moderately alkaline in reaction pH (8.06) with electrical conductivity of 0.48 ds m<sup>-1</sup>. The field capacity 29.23% and permanent wilting point 15.60% respectively with Bulk density 1.26 mg m<sup>-3</sup>.

The experiment was carried out in split-plot design with three replication. The net plot size was 2.40 m x 3.60 m (8.64 m<sup>2</sup>). The green manuring crops were kept in main plots (*kharif* season) and nutrient management levels kept in sub plots (*rabi* season). The main plot treatments (*kharif* season) comprised of four green manuring crop *viz.*, G<sub>1</sub> : sannhemp, G<sub>2</sub> : dhaincha, G<sub>3</sub> : cowpea, G<sub>4</sub> : greengram while the sub-plot treatments (*rabi* season) consisted of four nutrient management levels *viz.*, F<sub>1</sub> : 100% GRDF (120:60:120 N, P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O kg ha<sup>-1</sup> + 20 t ha<sup>-1</sup> of FYM, F<sub>2</sub> : 100% RDF (120:60:120 N, P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O kg ha<sup>-1</sup>), F<sub>3</sub> : 75% RDF (90:45:90

N, P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O kg ha<sup>-1</sup>), F<sub>4</sub> : 50% RDF (60:30:60 N, P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O kg ha<sup>-1</sup>). A common seed treatment with *Azotobactor* + PSB given to all treatments of potato. The recommended packages of practices were followed. The potato was planted after incorporation of green manuring crops.

Chemical quality parameters of potato *viz.* Total Soluble Salts (TSS) and Protein (%) and Sensor quality parameters of chips *viz.* Taste, Flavor, Texture crispiness and Overall acceptability are analyzed after of potato using standard methods, Jackson (1973) and (Morrison, 1956). The data recorded were statistically analyzed by using technique "Analysis of Variance" method. (Panse and Sukhatme, 1967), (Fisher, 1970) and significance was determined for split plot design (Panse and Sukhatme, 1984). The standard error of mean (SEM±) was worked out. The total variance (S<sub>2</sub>) and d.f. (n-1) were partitioned into different possible sources. The variance due to replication, crops, fertilizer levels and their interaction were compared with error variance for finding out 'f' values and ultimately for testing the significance at 5% level (P=0.005). The tested errors for the treatment based on error variance were calculated wherever, the result found to be significant, critical difference (C.D. = S.E. (m) ± X √2 x t at error d.f.) was calculated.

## RESULT AND DISCUSSION

The biomass of green manuring crops (t ha<sup>-1</sup>) are presented in Table 1 and graphically depicted in Fig.1. The sannhemp crop was recorded higher green biomass yield (25.40, 26.23 and 25.81 t ha<sup>-1</sup>) and dry matter yield (4.70, 4.77 and 4.73 t ha<sup>-1</sup>), respectively, followed by dhaincha crop (25.44, 25.26 and 24.85 t ha<sup>-1</sup>) and dry matter yield (4.02, 4.21 and 4.11 t ha<sup>-1</sup>), during first year, second year and pooled data, respectively. Similar results were reported by Kolar *et al.* (1993), Hongal (2001) and Nooli *et al.* (2001).

The plant height of potato increased significantly from 28 to 84 DAP during both the years of investigation were presented in Table 2 and 3. Residual effect of dhaincha crop (G<sub>2</sub>) incorporated at 50% of flowering stage in *kharif* season followed by growing of potato in *rabi* season with 100% general recommended dose of fertilizers (GRDF-120:60:120 N P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O kg ha<sup>-1</sup> + 20 tons of farm yard manure ha<sup>-1</sup>) recorded significantly maximum plant height of potato at all the days of observations over rest of the treatments. However it was at par with residual effect of sannhemp (G<sub>1</sub>) and 100 % of RDF (F<sub>2</sub>) at 28, 42 and 56 DAP during first year and 28, 56, 70, 84 DAP and at harvest during second year. This might be

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**Table 1**  
Biomass of green manuring crops

Treatment	Total green biomass ( $t\ ha^{-1}$ )			Total dry matter( $t\ ha^{-1}$ )		
	2013	2014	pooled	2013	2014	pooled
<i>Green manuring crops</i>						
G <sub>1</sub> -Sannhemp	25.40	26.23	25.81	4.70	4.77	4.73
G <sub>2</sub> -Dhaincha	24.44	25.26	24.85	4.02	4.21	4.11
G <sub>3</sub> -Cowpea	16.69	17.85	17.27	2.42	2.49	2.45
G <sub>4</sub> -Greengram	14.30	15.29	14.79	2.20	2.26	2.23
General mean	20.20	21.16	20.68	3.34	3.43	3.38

**Table 2**  
Periodical plant height of potato as influenced by different treatments (2013-14)

Treatment	Plant height (cm)					
	28 DAP	42 DAP	56 DAP	70 DAP	84 DAP	At harvest
<b>A. Green manuring crops</b>						
G <sub>1</sub> - Sannhemp	12.02	19.87	26.4	36.52	38.67	36.18
G <sub>2</sub> - Dhaincha	12.28	21.42	30.87	40.27	41.73	39.29
G <sub>3</sub> - Cowpea	10.63	16.15	22.15	33.65	37.47	36.01
G <sub>4</sub> - Greengram	11.00	15.6	21.95	36.03	37.68	35.39
SEm ±	0.15	0.61	0.94	0.41	0.51	0.57
C.D. at 5 %	0.51	2.12	3.25	1.40	1.75	1.96
<b>B. Nutrient management levels</b>						
F <sub>1</sub> - 100% GRDF	12.35	20.00	27.8	37.70	42.28	38.36
F <sub>2</sub> - 100% RDF	11.63	18.37	25.13	36.65	38.92	37.28
F <sub>3</sub> -75 % of RDF	11.28	17.18	24.75	35.23	37.15	36.14
F <sub>4</sub> -50% of RDF	10.67	17.48	23.68	33.80	36.98	35.10
SEm ±	0.13	0.62	0.97	0.43	0.49	0.73
C.D. at 5 %	0.37	1.82	2.84	1.26	1.43	2.12
<b>C. Interaction (AXB)</b>						
General mean	NS	NS	Sig.	Sig.	Sig.	NS
General mean	11.48	18.26	25.34	36.62	30.73	36.72

**Table 3**  
Periodical plant height of potato as influenced by different treatments (2014-15)

Treatment	Plant height (cm)					
	28 DAP	42 DAP	56 DAP	70 DAP	84 DAP	At harvest
<b>A. Green manuring crops</b>						
G <sub>1</sub> - Sannhemp	13.92	22.45	35.45	49.18	55.28	51.38
G <sub>2</sub> - Dhaincha	14.34	23.63	36.43	49.47	55.57	51.67
G <sub>3</sub> - Cowpea	13.22	20.13	31.45	46.93	52.78	48.88
G <sub>4</sub> - Greengram	12.7	20.08	34.70	47.68	54.32	49.42
SEm ±	0.30	0.63	0.32	0.42	0.56	0.56
C.D. at 5 %	1.02	2.17	1.11	1.44	1.93	1.93
<b>B. Nutrient management levels</b>						
F <sub>1</sub> - 100% GRDF	14.05	23.87	38.20	50.17	55.43	53.05
F <sub>2</sub> - 100% RDF	13.94	22.22	35.28	49.60	56.95	51.53
F <sub>3</sub> -75 % of RDF	13.19	21.48	33.72	47.48	52.82	48.92
F <sub>4</sub> -50% of RDF	13.20	20.73	30.83	46.72	52.75	48.85
SEm ±	0.22	0.69	0.71	0.86	0.80	0.80
C.D. at 5 %	0.65	2.01	2.08	2.50	2.32	2.32
<b>C. Interaction (AxB)</b>						
General mean	NS	NS	Sig.	Sig.	NS	NS
General mean	13.26	22.08	34.51	49.49	54.49	50.59

attributed to the availability of more plant nutrients under residual effect due to green manuring crops. Thus, clearly indicates that the plant height increased with the increasing availability of nutrients from green manuring crops during the crop growth period. This might be because of residual effect of preceding dhaincha as a green manuring crop, maintaining soil organic matter, major and micronutrients, which increases the uptake of essential nutrients and which accelerates the physiological activities of cell elongation and cell multiplication as a metabolic activities resulted in increasing all growth attributes of potato crop. These results are agreements with those reported by Khalak and Kumarswamy (1992), Singh *et al.* (1997), Shanmugsundara and Savitri (2000), Pawan and Mwaja (2005) and Meena *et al.* (2012).

The potato yield ( $t\ ha^{-1}$ ) were significantly higher during both the years of experimentation as well as

when pooled (**Table 4a, 4b and 4c**), incorporation of dhaincha at 50 % flowering stage as a green manuring crop in *kharif* season followed by growing of potato in *rabi* season with 100% general recommended dose of fertilizers (GRDF-120:60:120 N P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O kg ha<sup>-1</sup> + 20 tons of farm yard manure ha<sup>-1</sup>). This might be because of beneficial residual effect of *kharif* dhaincha as a green manuring crop by fixing atmospheric nitrogen through biological means and which may be available to mineralization of plant residues thereby increases the growth and yield of succeeding crop.

Moreover, for relazing higher yields in potato, the optimum ratio between green manuring and nutrient management was maintained with residual effect of G<sub>2</sub> *i.e* dhaincha and treatment F<sub>1</sub> *i.e* 100% GRDF. This might be because of beneficial residual effect of *kharif* dhaincha as a green manuring crop by fixing atmospheric nitrogen through biological means and

**Table 4a**  
Interaction effects between green manuring crops and nutrient management levels on yield of potato (2013-14)

Green manuring crops Nutrient managt. Levels	Total potato yield ( $t\ ha^{-1}$ )			
	G <sub>1</sub> - Sannhemp	G <sub>2</sub> - Dhaincha	G <sub>3</sub> - Cowpea	G <sub>4</sub> - Greengram
F <sub>1</sub> - 100% GRDF	33.02	35.03	29.00	31.00
F <sub>2</sub> - 100% RDF	28.11	31.08	30.20	28.26
F <sub>3</sub> - 75 % of RDF	24.39	26.28	23.42	25.54
F <sub>4</sub> - 50% of RDF	24.00	25.92	24.89	22.36
			SEm ±	C.D. at 5 %
Between two subplots means at same level between main plot mean			0.42	1.23
Between two main plots means at same level between sub plot mean			0.44	0.96

**Table 4b**  
Interaction effects between green manuring crops and nutrient management levels on yield of potato (2014-15)

Green manuring crops Nutrient managt. Levels	Total potato yield ( $t\ ha^{-1}$ )			
	G <sub>1</sub> - Sannhemp	G <sub>2</sub> - Dhaincha	G <sub>3</sub> - Cowpea	G <sub>4</sub> - Greengram
F <sub>1</sub> - 100% GRDF	32.00	38.61	26.25	29.22
F <sub>2</sub> - 100% RDF	31.92	32.39	29.94	32.31
F <sub>3</sub> - 75 % of RDF	26.39	28.53	25.53	30.43
F <sub>4</sub> - 50% of RDF	26.33	27.69	25.17	20.74
			SEm ±	C.D. at 5 %
Between two subplots means at same level between main plot mean			1.12	3.26
Between two main plots means at same level between sub plot mean			1.30	2.91

**Table 4c**  
Interaction effects between green manuring crops and nutrient management levels on yield of potato (pooled)

Green manuring crops Nutrient managt. Levels	Total potato yield ( $t\ ha^{-1}$ )			
	G <sub>1</sub> - Sannhemp	G <sub>2</sub> - Dhaincha	G <sub>3</sub> - Cowpea	G <sub>4</sub> - Greengram
F <sub>1</sub> - 100% GRDF	33.51	35.81	27.62	30.11
F <sub>2</sub> - 100% RDF	30.01	30.28	30.07	29.39
F <sub>3</sub> - 75 % of RDF	25.39	27.4	24.47	27.99
F <sub>4</sub> - 50% of RDF	25.17	29.15	25.03	21.55
			SEm ±	C.D. at 5 %
Between two subplots means at same level between main plot mean			0.77	2.25
Between two main plots means at same level between sub plot mean			0.87	1.94

which may be available to mineralization of plant residues thereby increases the growth and yield of succeeding crop. The dhaincha - potato cropping sequence were improved the soil health in respect of physical, chemical and biological properties which creates favorable condition for growth and development of crops and ultimately helps to increase the yield potential of potato crop. These results are in conformity finding of Singh and Raghav (2000) and Satyendra Kumar *et al.* (2006). The residual effect of dhaincha G<sub>2</sub> and treatment F<sub>1</sub> i.e 100% GRDF and exhibited photosynthesis surface (leaf area) which was the key contributor towards the yield diversity. Same kind of results was mentioned by Nair and Nair (1995), Netto *et al.* (1999), Patel *et al.* (2001) Campiglia *et al.* (2009) and Elsaid (*et al.*) 2014.

The important quality attributes *viz.*, protein, total soluble solids, overall acceptability of potato chips (Table 4 and 5 and graphically depicted in fig. 2 and 3) were also improved significantly with the residual effect of dhaincha (G<sub>2</sub>) as a green manuring crop and treatment (F<sub>1</sub>) 100% GRDF during both the years of investigation. This might be ascribed to the increased N uptake of leaves and tuber which is useful for synthesis of amino acid and translocation of potato tuber and improved protein content. This result was accordance with findings of Westermann and Kleinkopf (1985), Lisiska (1989), Gronowicz *et al.* (1992) and Yin Gang (2003).

**CONCLUSION**

It may be concluded from the finding of this study based on the two years experimentation incorporation of dhaincha at 50% of flowering stage as a green manuring crop in *khari*f season and application of 100% general recommended dose of fertilizers (RDF-

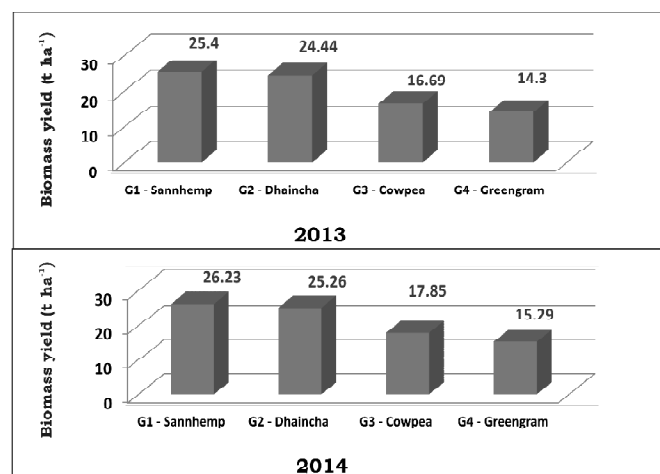


Figure 1: Biomass of green manuring crops (t ha<sup>-1</sup>)

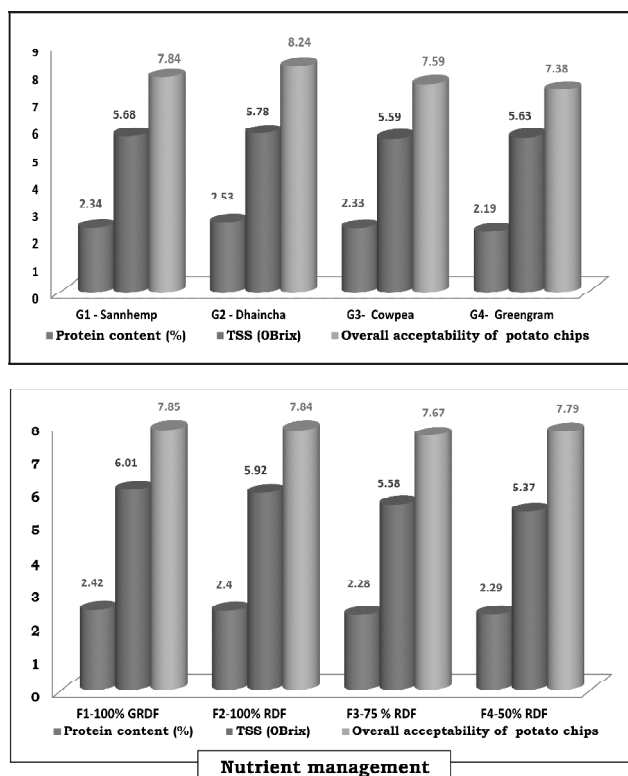


Figure 2: Quality parameters of potato as influenced by different treatments during 2013-14

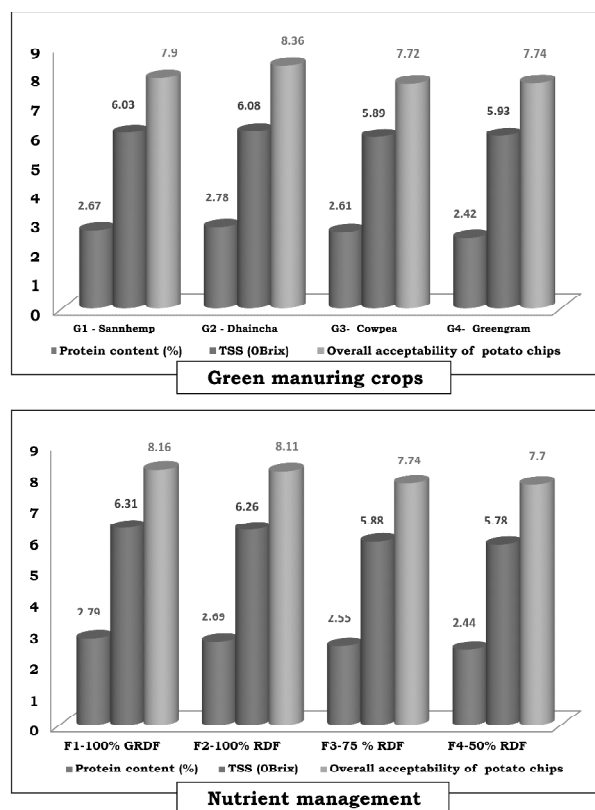


Figure 3: Quality parameters of potato as influenced by different treatments during 2014-15

120:60:120 N P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O kg ha<sup>-1</sup> + 20 tons of farm yard manure ha<sup>-1</sup>) to potato in *rabi* season was found beneficial in terms of growth, quality parameters and potato yield.

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