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RESEARCH ARTICLE

EFFECT OF INORGANIC AND ORGANIC SOURCES OF NUTRIENTS ON NUTRIENT UPTAKE, YIELD AND ECONOMICS OF PROCESSING POTATO (SOLONUM TUBERSUM L.).

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Abstract

An experiment was conducted during 2011-12 and 2012-13 in the Division of Agronomy, Faculty of Agriculture, Khasla College, Amritsar to study the effect of inorganic fertilizers and various organic manures on productivity, nutrient uptake and profitability of processing type autumn potato (*Solanum tuberosum* L.). The large sized (>40g) potato tubers and total tuber yield was statistically at par with inorganic fertilizers and 100 per cent nitrogen through vermin-compost. With inorganic fertilizers applications, the large sized potato tubers and total potato tuber yield was observed 5.82 per cent and 6.86 per cent more than application of 100 per N through vermi-compost, but total income, net income and benefit cost ratio was found higher with 100% nitrogen through vermin-compost followed by 100% N through DRS. These organic source of nutrients were statistically comparable with inorganic sources of nutrients. Sole application of organic sources of nutrients were equally efficient to inorganic fertilizers in improving the nutrients uptake, tuber yield and benefit: cost ratio (B: C).
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Modern agriculture had led to the development of high yielding crop cultivars (with assured supply of chemical fertilizers) but lacks the ability to their potential of production. Synthetic fertilizers applications and poor crop residue management had not addressed the environmental problems in modern agriculture. The ill practices followed by the Punjab farmers viz. burning of paddy straw has deteriorated and intensified the pollution growth to its highest. A lot of emphasis has been placed on identifying alternatives to the inorganic fertilizers, burning of rice straw and over use of synthetic chemicals, which are blamed for most of the problems associated with conventional agriculture. The need to realize highest crop productivity per unit of time and farm mechanization have led to the adoption of modern farming technologies, which have placed heavy reliance on irrigation, high yielding varieties, inorganic sources of fertilizers, weedicides and pesticides. Use of various organic manures, microbial pesticides, natural plant products and natural enemies has been advocated as substitutes for inorganic crop cultivation. The instability of agro-ecosystems, which can be linked to heavy use of inorganic sources of fertilizers and burning of rice straw in fields, needs to be repaired by restoring the elements of ecological homeostasis through the addition or enhancement of organic sources of nutrients and better crop residue management practices which may not only meet our basic requirements for food, fiber and shelter but also to address environmental health. More over organic produce contains more vitamins, minerals, enzymes, trace elements and even cancer fighting antioxidants than conventionally grown food (Bhattacharya and Chakraborty, 2005). Whereas better crop residue management such as addition of crop residues to fields through decomposed rice straw and chopped rice straw may help to improve soil health by increasing organic matter and nutrients in soils. Organic farming and selection of cash crop like potato for processing purposes, appears to be one of the best options for sustainability which may improve the economics of the Indian farmers in general and of the Punjab farmers in particular. Therefore, the present UGC sponsored research project was planned in the autumn seasons of the year 2011-12 and 2012-13 with the objectives to study the effect of inorganic fertilizers and various organic sources of nutrients on NPK uptake, yield and economics of processing variety of potato.

Materials and methods:-

A UGC sponsored field experiments were initiated during autumn season in the year 2011-12 and 2012-13 at Student's Research Farm, Khalsa College, Amritsar, Punjab, India to assess the effect of inorganic and various organic sources of nutrient on nutrient uptake, tuber yield and economics of various treatment. The field trail was laid out in complete randomized design with seven treatments (Control, 100 per cent NPK (187.5 kg nitrogen, 100 kg P_2O_5, 125 kg K_2O/ha) through inorganic sources, 100 percent nitrogen through farmyard manure (FYM), 100 per cent nitrogen through poultry manure (PM), 100% nitrogen through vermicompost (VC), 100% nitrogen through chopped rice straw (CRS), 100 per cent of nitrogen through decomposed rice straw (DRS), in four replications. Before planting of potato crop mechanical and chemical analysis of composite soil samples were performed to determine particle size distribution and fertility status of the field in both the years and average figures were calculated.

The soil of experimental field was sandy loam in nature with EC 0.22 m mhos/cm^2 (Jackson, 1967), pH 7.7, organic carbon 0.28%, available NPK 164, 20.1 and 342 kg/ha. The recommended variety Kufri Chipsona no. 3 was planted at distance 60 × 20 cm in first week of October in both the study years (2011-12 and 2012-13), using normal seed rate 35 q/ha medium size (20-40 g) tubers. Various sources of organic manures were analyzed for nutrient content (Table 1) and applied before sowing of autumn potato on oven-dry basis @ 29.76 t FYM/ha, 10.42 t PM/ha, 15.63 t VC/ha, 43.60 t CRS/ha and 24.04 t DRS/ha by taking nitrogen at constant rate of 187.5 kg/ha. Three plants were randomly selected for taking all observations and analysis for nutrient uptake. The tuber yield was worked out on net plot yield. The analysis and interpretation of data were done by using CPCSI software developed by Department of Mathematics and Statistics, PAU, Ludhiana and as per randomized block design (Cochran and Cox, 1963). The additional costs involved and returns obtained with different organic manures and inorganic fertilizers were worked out on the basis of market rates of all the applied inputs during experiment on per hectare basis. The benefit: cost (B:C) ratio was calculated on the basis of formula as B:C ratio = Total returns/Total cost of cultivation.

Results and discussion:-

Yield Performance:-

Yield performance of autumn sown processing variety of potato chipsona No. 3 varied significantly with application of different sources of organic manures and inorganic fertilizers (Table 2) over control. Maximum and significantly higher number of tubers per plant were found with 100 per cent nitrogen through inorganic fertilizers as compared to other treatments. Among organic treatments, maximum tubers/plant were observed in 100 per cent nitrogen through VC followed by 100 per cent nitrogen through DRS which were 66.48 and 60.89 per cent more over control.

Irrespective to inorganic and various organic treatments, the proportion of large sized tubers (> 40 g) were higher as compare to medium (20-40 g) and small sized (< 20 g) tubers. Maximum large sized tubers were found in treatment 100 per cent nitrogen through NPK which was statistically 5.82 and 7.64 per cent higher than treatment 100 per cent nitrogen through VC and 100 per cent nitrogen through DRS respectively. Among organic treatments, highest number of large size tubers were found when 100 per cent N was applied through VC which was 1.93 per cent more than 100 per cent nitrogen through DRS and both the treatments were 74.14 and 73.63 per cent higher over control. Similar trends were found for medium size and small size tubers. Maximum total tuber yield was observed when 100 per cent NPK was applied through in-organic fertilizers which was numerically at par 100 per cent N through VC. Among organic treatments 100 per cent application of nitrogen through VC and DRS were found statistically at par but significantly higher than all other treatments. 100 per cent nitrogen through VC and 100 per cent N through DRS were 10.38 per cent and 9.08 per cent higher than FYM and 54.68 and 54.02 per cent more than control. However increase in yield with addition of different inorganic or organic sources of nutrients might be owing to increase in availability of NPK and built up of organic carbon. Tuber yield is influenced to great extent by growth, nutrients and moisture supply. Nitrogen forms the constituents of chlorophyll for the plants and hence photosynthesis. The N is also a part of amino acids and proteins that takes part in cell division and enlargement there by, increasing the weight of individual potato tuber and ultimately yield. K being an activator of enzyme involved in carbohydrate synthesis, which ultimately lead to higher tuber yield. The increase in yield with the application of 100 per cent nitrogen through NPK, FYM, CRS, VC, PM and DRS could be attributed to corresponding increase in leaf area, which was responsible for synthesizing photosynthetic and increase in number and weight of potato tubers. Increase in yield with manures was also reported by Lal and Sharma (1995) and Shambhavi et al. (2008). Addition

of decomposed rice straw as manure not only helps to enhance the potato tubers yield, NPK uptake and net returns but also a best way out to save environment and burning of rice straw in field.

Nutrients Uptake:-

The present findings pertaining to uptake of nitrogen, phosphorus and potassium in potato tubers influenced significantly with application of different sources of organic manures and inorganic fertilizers than control (Table 3). Highest and statistically at par total nutrient uptake was observed in 100 per cent NPK applied through inorganic source of nutrients and 100 per cent nitrogen through vermin-compost as compare to all other organic manures. Among organic manures application of 100 per cent nitrogen through VC and 100 per cent N through DRS showed significantly higher uptake of NPK as compared to all other treatments. Total nutrients uptake in treatment with 100 per cent nitrogen through VC was observed statistically at par to treatment 100 per cent nitrogen through DRS. This might be because of narrow C:N ratio, continuous release of nutrients through the crop growth period and release of organic acids, which would have aided in the solubilization of minerals and change over from non-exchangeable to exchangeable form of nutrients which led to direct and early absorption of nitrogen, phosphorus and potassium resulting in better uptake of nutrients (Sasani et al., 2003). Apart this, the increase in total uptake of NPK with application of organic manures might be due to improvement in inherent nutrient supplying capacity of soil, balanced supply of nutrients throughout the crop growth period, increased availability of nutrients and also by increasing nutrients efficiency (Kaminvar and Rajagopal, 1990; Das et al. 1991).

Economics of Various Treatments:-

The minimum cost of production was observed in control and it was maximum for 100 per cent N through DRS (Table 4). The highest net returns were obtained with 100 per cent N through VC, closely followed by 100 per cent through DRS. Applications of 100 per cent FYM and 100 per cent N through PM gave better net returns as compare to 100 per cent N through inorganic fertilizers and as well as that of control. Even direct application of 100 per cent of N through CRS proved better results over control. Use of 100 per cent nitrogen through VC and 100 per cent N through DRS have higher net returns as compare to other organic manures and inorganic fertilizer treatment. Similarly, the returns per rupee invested on production inputs with 100 per cent N through VC gave higher returns over all other treatments. 100 per cent N through DRS also reported to be better option as compare to 100 per cent N through FYM and 100 per cent N through inorganic fertilizers. It is pertinent to mention here that as compare to direct addition of 100 per cent N through chopped rice straw, the addition of 100 per cent N through decomposed rice straw performed far better. 100 per cent N through CRS performed quite poor with minimum tuber yield, nutrient uptake and benefit cost ratio as compare to all other treatments except control. As the temperature during the growth period declines on day to day basis, which play a key role to delay decomposition of the rice straw which may not be able to supply nutrients to the crop plants. These results were in tune to the findings of Raghav et al. (2007). In present experiment results revealed that application of 100 per cent N through inorganic source of nutrients and 100 per cent N through VC were better alternative for higher crop yield, NPK uptake and profitability of processing type autumn potato.

Table 1: Quantity (kg/ha) of N, P and K added through various organic manures (mean of two years).

Organic Manure	Organic Carbon (%)	Nutrient Content (%)			Nutrients Added (Kg/ha)			C:N Ratio
		N	P	K	N	P	K	
FYM	13.23	0.63	0.25	0.31	187.5	74.41	92.26	21:1
PM	21.6	1.80	0.46	1.20	187.5	47.92	125.00	12:1
VC	19.20	1.20	0.62	0.91	187.5	96.88	142.19	16:1
CRS	26.66	0.43	0.06	0.47	187.5	26.16	265.98	62:1
DRS	14.82	0.78	0.47	1.28	187.5	112.68	307.69	19:1

FYM = Farm yard manure **C = Carbon**
PM = Poultry manure **N = Nitrogen**
VC = Vermi-compost **P = Phosphorus**
CRS = Chopped rice straw **K = Potassium**
DRS = Decomposed rice straw **C:N = Carbon: Nitrogen**

Table 2: Effect of inorganic and organic sources of nutrients on tuber yield (q/ha) of potato (mean of two years).

Treatments	**No. of tubers per plant**	**Tuber yield (q /ha)**			
		Grade Wise			
		Large (>40g)	**Medium (20-40g)**	**Small (<20g)**	**Total tuber yield (q/ ha)**
Control	03.52	45.60	53.72	33.49	145.81
100% N through NPK	12.32	187.20	109.11	49.12	345.42
100% N through FYM	08.02	156.18	79.09	53.07	288.31
100% N through PM	07.25	145.44	69.44	57.44	271.33
100% N through VC	10.50	176.31	89.24	55.20	321.72
100% N through CRS	05.25	92.12	64.18	45.12	201.35
100% N through DRS	09.00	172.90	81.71	62.51	317.11
C.D. (5%)	1.64	14.37	2.90	2.33	24.99

Table 3: Effect of inorganic and various organic sources of nutrients on N, P, K uptake (kg/ha) by potato tubers (mean of two years).

	NPK uptake (kg/ha)		
Treatments	**N uptake**	**P uptake**	**K uptake**
Control	55.73	11.03	93.10
100% N through NPK	116.36	25.30	162.52
100% N through FYM	109.58	19.00	153.47
100% N through PM	108.23	17.30	152.12
100% N through VC	114.26	23.28	158.38
100% N through CRS	87.61	16.51	119.22
100% N through DRS	112.80	21.39	156.00
CD (5%)	2.98	2.43	3.08

Table 4: Economic analysis (in Rs/ha) of organic and inorganic sources of nutrients for potato crop in Amritsar District (mean of two years).

Treatments	Land Rent (Rs./ha)	Seed bed preparation (Rs./ha)	Labour (Rs./ha)	Harvesting labour (Rs./ha)	Seed (Rs./ha)	Manure and Fertilizer (Rs./ha)	Total input cost (Rs/ha)	Total income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Control	25,000	5500	2350	8500	4500	0.00	45,850.00	72,905.00	27,055.00	1.59
100% N through NPK	25,000	5500	2350	8500	4500	11,056.00	56,906.00	1,72,710.00	1,15,804.00	3.04
100% N through FYM	25,000	5500	2350	8500	4500	29,761	75611.90	2,30,648.00	1,55,036.10	3.05
100% N through PM	25,000	5500	2350	8500	4500	31,250.00	77,100.00	2,17,064.00	1,39,964.00	2.82
100% N through VC	25,000	5500	2350	8500	4500	31250.06	77100.00	2,57,376.00	1,80,276.00	3.34
100% N through CRS	25,000	5500	2350	8500	4500	21802.33	67652.30	1,16,080.00	48427.67	1.72
100% N through DRS	25,000	5500	2350	8500	4500	36057.69	81907.69	2,53,688.00	1,71,780.31	3.10

Prevailing cost of various inputs

1. Nitrogen (urea) = Rs. 5.40/kg
2. Phasphorus (DAP) = Rs. 25.40/kg
3. Potassium (MOP) = Rs. 16.00/kg
4. Farm yard manure = Rs. 1/kg
5. Poultry manure = Rs. 3/kg
6. Vermicompost = Rs. 2/kg
7. Chopped rice straw = Rs. 0.5/kg
8. Decompost rice straw= Rs. 1.5/kg
9. Selling price of potatoes (inorganic) = Rs. 5/kg
10. Selling price of potatoes (organic) = Rs. 8/kg

References:-

1. Bhattacharya, P. and Chakraborty, G., (2005). Current status of organic farming in India and other countries. Indian Journal of Fertilizers **1(9):** 111-23.
2. Cochran, W.G. and Cox, G.M. (1963). Experimental Designs. Asia Pub. House, New Delhi.
3. Das, P.K., Sethi, A.K., Jena, M.K. and Patra, R.K. (1999). Effect of P source and dual inoculation of VAM and Rhizobium on dry matter yield and nutrient uptake by green gram (Vigna radiate L.). Journal Indian Society of Soil Science **47:** 466-470.
4. Jackson, M.L. (1967). Soil Chemical Analysis. Prentice Hall of India Ltd. New Delhi, India.
5. Kaminwar, S.P. and Rajagopal, V. (1993). Fertilizer response and nutrient requirement of rainfed chilies in Andhra Pradesh. Fertilizer News **38:** 21-26.
6. Lal, B. and Sharma, S.P. (1995). Response of potato (Solanum tuberosum) to potassium application in mid hill soils of Himachal Pradesh. Indian Journal of Agricultural Sciences **65(6):** 433-34.
7. Raghav, M. Kumar, T. and Kamal, S. (2007). Effect of organic sources of nutrients on growth, yield and quality of potato. Progressive Horticulture **39(1):** 95-100.
8. Sasani, G.V., Patel, C.K., Patel, R.N. and Patel, N.H. (2003). Effect of levels of inorganic fertilizers with and without organic manures on yield of potato in North Gujarat. J. Indian Potato Assoc. **30:** 77-78.
9. Shambhavi, S. and Sharma, R.P. (2008). Influence of VC on quality of potato (Solanum tuberosum) in wet temperature zone of Himachal Pradesh. Indian Journal of Plant Physiology **13(2):** 185-90.