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Influence of Organic Nutrient Sources on Growth and Yield of Potato (*Solanum tuberosum* L.) in Southern Transitional Zone of Karnataka

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Abstract

The experiment was conducted to study the 'Influence of Organic Nutrient Sources on Growth and Yield of Potato (*Solanum tuberosum* L.) in Southern Transitional Zone of Karnataka' at College of Agriculture, Hassan. The experiment was laid out in randomised complete block design with three replications. Application of recommended dose of nutrients @ 25 t FYM ha-1 with 75:75:100 kg of N,$P_2O_5K_2O$ ha^{-1} registered significantly higher plant height (38.8 cm), number of shoots plant^{-1} (3.1) and number of leaves (10.9) followed by application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by panchagavya foliar spray at 30, 45 and 60 DAP (1:1 dilution with water). Application of recommended dose of nutrients @ 25 t FYM ha-1 with 75:75:100 kg of N,$P_2O_5K_2O$ ha^{-1} recorded significantly higher total dry matter at harvest 52.4 gm plant^{-1} followed by 50 per cent RDN through FYM + 50 per cent RDN through VC, fb PG foliar spray at 30, 45 and 60 DAP (1:1 dilution with water) (51.6 gm plant^{-1}). Application of recommended dose of nutrients @ 25 t FYM ha-1with 75:75:100 kg of NPK ha^{-1} recorded significantly higher tuber weight (139.3 g plant^{-1}), tuber number (5.1 plant^{-1}), tuber yield (17.1 t ha^{-1}) and also different grades of A, B, C and D tubers (2.9, 5.3, 5.00 and 3.8 t ha^{-1} respectively); closely followed by application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost; followed by panchagavya foliar spray at 30, 45 and 60 DAP (1:1 dilution with water) which recorded tuber weight of 134.7 g plant^{-1}, tuber number of 4.9 plant^{-1} and tuber yield of 16.5 t ha^{-1}. Higher B:C ratio (2.24) was recorded in 50 per cent RDN through FYM + 50 per cent RDN through VC, fb PG foliar spray at 30, 45 and 60 DAP (1:1 dilution with water).

Keywords: Potato, Vermi-compost, Panchagavya, Cow urine

The potato (*Solanum tuberosum* L.) is native to the Andean region of South America. It ranks as the world's fourth most important food crop, after maize, wheat and rice and represents a valuable source of nutrients in a balanced diet. Potato is a member of the *Solanaceae* family and it has the capacity to produce more energy and protein per unit area per unit time. Potato protein is superior to that of cereals and rich in essential amino acid 'lysine' and vitamin C. Potato is rich in starch. Hence, potato is one of the richest sources of calories needed to maintain day-to-day output of human energy. It is an herbaceous annual plant that grows up to 100 cm tall and produces tubers also called 'potato' which develops from an underground stem called 'stolon' or 'rhizome'. As the potato plant grows, its compound leaves manufacture starch that is transferred to the ends of its underground stems. Tubers have lenticels that facilitate gas exchange. The number of tubers that actually reach maturity depends on available moisture and soil nutrients. Each tuber has two to 10 buds (or 'eyes'), arranged in a spiral pattern around its surface. The buds generate shoots that grow into new plants when conditions are favourable. Potato is a short duration crop and is heavily fertilized with inorganic fertilizers and sprayed with fungicides to control late blight disease by farmers to get higher yield. Potato being an exhaustive crop needs heavy application of fertilizers to put forth good growth and higher yield. Hence it is being grown under intensive cultivation by using inorganic inputs. It is well documented fact that continuous and non judicious use of inorganic inputs or commercial fertilizers and pesticides have an adverse effect on soil health and environment and these are found to be expensive, unsafe, not much affordable by small and marginal farmers and leaving

residual toxicity in the food products there by reduces the quality. High chemical inputs usage has led to the neglect of good traditional practices and it is necessary to reduce the dependence on chemical inputs by adopting alternative source of plant nutrients and one such alternative is organic farming. Keeping all these points in view the present study entitled 'Influence of Organic Nutrient Sources on Growth and Yield in Potato (*Solanum tuberosum* L.) in Southern Transitional Zone of Karnataka.' was conducted during 2015.

Material and Methods

A field experiment was conducted during *kharif* 2015 at College of Agriculture, Hassan and Karnataka. The experiment was laid out in randomised complete block design with three replications. The experiment was laid out in red sandy loam with neutral pH (6.78), EC (0.09 dSm^{-1}), Organic carbon (0.46 %), Low available N (333.6 kg ha^{-1}), Medium available P_2O_5 (53.9 kg ha^{-1}), Low available K_2O (213.0 kg ha^{-1}). The experimental site is geographically situated in the Southern Transitional Zone (Zone - 7) of Karnataka and located between 12º 13' and 13º 33' N Latitude and 75º 33' and 76º 38' E Longitude at an altitude of 827 m above Mean Sea Level (MSL). The experiment consisted of nine treatments with three replications laid in RCBD design. The treatments details are as follows.

Treatment Details

Nine treatment combinations were laid out in randomized complete block design with three replications as detailed below :

T_1 : Recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of N,P_2O_5,K_2O ha^{-1}

T_2 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by cow urine foliar spray at 30, 45, 60 DAP (1:1 dilution with water)

T_3 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by Fermented butter milk foliar spray at 30, 45, 60 DAP (1:1 dilution with water)

T_4 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by 5 per cent Bio-fuel oil cake solution foliar spray at 30, 45 and 60 DAP.

T_5 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by 0.5 per cent silica foliar spray at 30, 45 and 60 DAP

T_6 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by Compost tea foliar spray at 30, 45 and 60 DAP (500 l ha^{-1})

T_7 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by Panchagavya foliar spray at 30, 45 and 60 DAP (1:1 dilution with water)

T_8 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by Jeevamrutha foliar spray at 30, 45 and 60 DAP (1:1 dilution with water)

T_9 : 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, Followed by cow urine + Fermented butter milk foliar spray at 30 DAP, Followed by PG: Panchagavya + Jeevamrutha foliar spray at 45 DAP, Followed by 5 per cent Bio-fuel oil cake solution + Compost tea foliar spray at 60 DAP

Note: RDN: Recommended dose of nitrogen.

Plot size

Gross plot : 4.8 m x 3.6 m = 17.28 m^2

Net plot : 3.6 m x 3.2 m = 11.52 m^2

Results and Discussion

Growth Components

Plant Height (cm)

At harvest, significantly higher plant height (38.8 cm) was recorded with application of recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} which was on par with treatments *viz.*, 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by panchagavya foliar spray at 30, 45 and 60 DAP, 50 per cent RDN through FYM

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+ 50 per cent RDN through vermi-compost, followed by jeevamrutha foliar spray at 30, 45 and 60 DAP and 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by cow urine + butter milk foliar spray at 30 DAP, followed by panchagvya + jeevamrutha foliar spray at 45 DAP, followed by 5 per cent bio-fuel oil cake + compost tea foliar spray at 60 DAP (36.8, 35.8 and 33.5 cm, respectively). Significantly lower plant height (25.0 cm) was recorded in application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45 and 60 DAP.

Plant height of potato was significantly higher in treatment with application of recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} at harvest (38.8 cm). Significantly lower plant height was recorded in treatment with application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at harvest (25.0 cm). This was due to availability of nutrients in root zone of plants, where the plants are able to utilize all the nutrients effectively and meets the nutrient demand of the crop. Slow release of organic nutrients to soiled to slow uptake by the plant.

TABLE 1

Effect of different organic nutrient sprays on growth parameters of potato at different growth stages

Treatments	Plant height at harvest (cm)	Shoot numbers at 60 DAS	Number of leaves at harvest	Leaf Area at harvest (cm^2)
T_1 : Recommended dose of nutrients of 25 t FYM ha^{-1}+75:75:100 kg of NPK ha^{-1}.	38.8	3.1	10.9	848
T_2 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CU foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	29.5	2.6	9.0	462
T_3 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb FBM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	28.6	2.4	8.4	292
T_4 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb 5 per cent BOC foliar spray at 30, 45, 60 DAP.	25.0	2.2	7.8	168
T_5 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb 0.5 per cent silica foliar spray at 30, 45, 60 DAP.	30.1	2.4	7.9	191
T_6 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CT foliar spray at 30, 45, 60 DAP (500 l ha^{-1}).	29.1	2.5	8.9	460
T_7 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb PG foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	36.8	3.0	9.8	761
T_8 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb JM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	35.8	2.9	9.3	681
T_9 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CU + FBM foliar spray at 30 DAP, fb PG + JM foliar spray at45 DAP, fb 5 per cent BOC + CT foliar spray at 60 DAP.	33.5	2.8	9.2	522
S.Em.±	2.5	0.1	0.2	59
CD (P= 0.05)	7.6	0.4	0.8	176

Note : VC : Vermicompost, fb: Followed by, CU: cow urine, FBM: Fermented butter milk, BOC: Biofuel oil cake solution, CT: Compost tea, PG: Panchagavya, JM: Jeevamrutha, RDN: Recommended dose of nitrogen

Number of Shoots Plant^{-1}

At 60 DAP, significantly higher number of shoots plant^{-1} (3.1) were recorded with the application of recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1}, which was on par with treatments *viz.,* 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by panchagavya foliar spray at 30, 45 and 60 DAP, 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by jeevamrutha foliar spray at 30, 45 and 60 DAP and 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by cow urine + butter milk foliar spray at 30 DAP, followed by panchagavya + jeevamrutha foliar spray at 45 DAP, followed by 5 per cent bio-fuel oil cake + compost tea foliar spray at 60 DAP (3.0, 2.9 and 2.8 respectively). Significantly lower number of shoots plant^{-1} (2.2) was recorded with the application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45, 60 DAP. During this growth period, nitrogen favours stem growth. However, at a later growth stage, the tubers can take benefit from increased above ground biomass. Here, N has a decisive impact on the number of emerging leaves and the rate of leaf expansion, and, therefore, on the canopy development of the plant (Ospina *et al.* 2014).

Number of Leaves Plant^{-1} and Leaf Area Plant^{-1} (cm^2)

At harvest, number of leaves plant^{-1} was significantly higher with application of recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} (10.9) compared with application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45 and 60 DAP (7.8).

At harvest, treatment with application of recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} recorded significantly higher leaf area plant^{-1} (848 cm^2) which was on par with application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by panchagavya foliar spray at 30, 45, 60 DAP (761 cm^2). Significantly lower leaf area plant^{-1} (168 cm^2) was recorded with application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45, 60 DAP.

The photosynthetic efficiency of crop plants as measured by net assimilation rate is dependent upon photosynthetic capacity expressed as leaf area index. Under field conditions, an increase in LAI may therefore improve the yield, provided such an increase commensurate with an increased rate of dry matter production in reproductive parts. Leaf area over unit ground area gives a fairly good idea of the photosynthetic surface.

Leaf area growth determines the light interception capacity of a crop and is often used as a surrogate for plant growth is high-through-out phenotyping systems. The relationship between leaf area growth and growth in terms of mass will depend on how carbon is partitioned among new leaf area, leaf mass, root mass, reproduction and respiration.

Number of leaves per plant was significantly higher (10.9 plant^{-1} at harvest) with application of recommended dose of nutrients of 25t FYM ha^{-1} + 75:75:100 kg of N,P_2O_5,K_2O ha^{-1} compared to application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45, 60 DAP (7.82 plant^{-1} at harvest). This might be due to higher uptake of nutrients through fertilizer and FYM improved production of dry matter which intern resulted in more number of leaves and leaf area (Richa Khanna 2013).

Total Dry Matter Production (g plant^{-1})

The data on total dry matter (g plant^{-1}) of potato at different stages (30, 45, 60 and 75 DAP and harvest) as influenced by different organic nutrient sprays is presented in Table 2

At 30 DAP, application of recommended dose of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} recorded significantly the higher dry matter (7.0 g plant^{-1}) closely

TABLE 2

Effect of different organic nutrient sprays on total dry matter production at different growth stages in potato

Treatments	Total dry matter (g plant^{-1})				
	30 DAP	45 DAP	60 DAP	75 DAP	At harvest
T_1 = Recommended dose of nutrients of 25 t FYM ha^{-1}+75:75:100 kg of NPK ha^{-1}.	7.0	48.7	51.4	50.3	52.4
T_2 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CU foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	4.6	42.1	44.5	43.4	45.5
T_3 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb FBM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	3.4	33.7	35.5	34.9	36.5
T_4 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb 5 per cent BOC foliar spray at 30, 45, 60 DAP.	2.4	26.5	29.4	27.9	29.4
T_5 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb 0.5 per cent silica foliar spray at 30, 45, 60 DAP.	3.1	28.0	31.2	29.5	31.8
T_6 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CT foliar spray at 30, 45, 60 DAP (500 l ha^{-1}).	3.7	36.1	39.2	38.6	40.1
T_7 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb PG foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	6.1	48.0	50.2	49.3	51.6
T_8 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb JM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	5.6	46.1	48.6	47.3	49.9
T_9 = 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CU + FBM foliar spray at 30 DAP, fb PG + JM foliar spray at 45 DAP, fb 5 per cent BOC + CT foliar spray at 60 DAP.	4.9	44.7	47.5	46.4	48.1
S.Em. ±	0.4	1.91	2.2	1.8	1.9
CD (P = 0.05)	1.2	5.7	6.7	5.6	5.7

Note : VC: Vermicompost, fb: Followed by, CU: cow urine, FBM: Fermented butter milk, BOC: Biofuel oil cake solution, CT: Compost tea, PG: Panchagavya, JM: Jeevamrutha, RDN: Recommended dose of nitrogen

followed by treatment with application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by panchagavya foliar spray at 30, 45 and 60 DAP (6.1 g plant^{-1}). Significantly lower dry matter (2.4 g plant^{-1}) was recorded in treatment with application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by 5 per cent biofuel oil cake foliar spray at 30, 45 and 60 DAP.

At 45 DAP, application of recommended dose of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} recorded significantly higher dry matter production (48.7 g plant^{-1}) compared to treatment with application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by 5 per cent biofuel oil cake foliar spray at 30, 45 and 60 DAP (26.5 g plant^{-1}) except treatments *viz*., 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by panchagavya foliar spray at 30, 45 and 60 DAP, 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by jeevamrutha foliar spray at 30, 45 and 60 DAP and 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by cow urine + butter milk foliar spray at 30 DAP, followed by panchagvya + jeevamrutha foliar spray at 45 DAP, followed by 5 per cent biofuel oil cake + compost tea foliar spray at 60 DAP (48.0, 46.1 and 44.7 g plant^{-1}, respectively).

At 60 DAP, application of recommended dose of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} recorded

significantly higher dry matter (51.4 g plant^{-1}) compared to application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by 5 per cent biofuel oil cake foliar spray at 30, 45 and 60 DAP (29.4 g plant^{-1}) except treatments *viz*., 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by panchagavya foliar spray at 30, 45 and 60 DAP, 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by jeevamrutha foliar spray at 30, 45 and 60 DAP and 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by cow urine + butter milk foliar spray at 30 DAP, followed by panchagvya + jeevamrutha foliar spray at 45 DAP, followed by 5 per cent biofuel oil cake + compost tea foliar spray at 60 DAP (50.2, 48.6 and 47.5 g plant^{-1}, respectively).

At 75 DAP, significantly higher dry matter (50.3 g plant^{-1}) was observed with application of recommended dose of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1}. This was on par with treatments *viz.*, 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by panchagavya foliar spray at 30, 45 and 60 DAP, 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by jeevamrutha foliar spray at 30, 45 and 60 DAP and 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by cow urine + butter milk foliar spray at 30 DAP, followed by panchagvya + jeevamrutha foliar spray at 45 DAP, followed by 5 per cent biofuel oil cake + compost tea foliar spary at 60 DAP (49.3, 47.3 and 46.4 g plant^{-1}, respectively). Significantly lower dry matter (27.9 g plant^{-1}) was recorded with application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by 5 per cent biofuel oil cake foliar spray at 30, 45 and 60 DAP.

At harvest, application of recommended dose of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} recorded significantly higher dry matter (52.4 g plant^{-1}) compared to application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by 5 per cent biofuel oil cake foliar spray at 30, 45 and 60 DAP (29.4 g plant^{-1}) except treatments *viz*., 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by panchagavya foliar spray at 30, 45 and 60 DAP, 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by jeevamrutha foliar spray at 30, 45 and 60 DAP and 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by cow urine + butter milk foliar spray at 30 DAP, followed by panchagvya + jeevamrutha foliar spray at 45 DAP, followed by 5 per cent biofuel oil cake + compost tea foliar spray at 60 DAP (51.6, 49.9 and 48.1 g plant^{-1}, respectively). The increase in dry matter in plant may be attributed to increased leaf area and consequent increase in production of photosythates, better root growth and spread due to the application of higher fertilizers which helped in increasing absorption of nutrients and also translocation of photosythates to different parts of plant. Similar trend was also observed in all the growth stages.

Yield Parameters

The data on yield parameters *viz.,* tuber weight plant^{-1}, number of tubers plant^{-1}, tuber grading and tuber yield (t ha^{-1}) as influenced by different organic nutrients sprays in potato are presented in Table 3.

Tuber Weight Plant^{-1}

Higher tuber weight (139.3 g plant^{-1}) was recorded with application of recommended dose of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} and lower tuber weight (98.0 g plant^{-1}) was recorded with application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45, 60 DAP.

Number of Tubers Plant^{-1}

There was no significant differences among treatments. Higher number of tuber (5.1 plant^{-1}) was recorded with application of recommended dose of nutrients with application of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1}. Lower number of tubers were recorded with application of 50 per cent RDN through FYM + 50 per cent RDN through Vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45 and 60 DAP (3.8 plant^{-1}).

TABLE 3

Effect of different organic nutrient sprays on yield parameters of potato at harvest

Treatments	Tuber weight (g/plant)	No. of tubers	Tuber grading (t ha^{-1})				
			D (<25 g)	C (25 - 50 g)	B (50 - 75 g)	A (>75 g)	Tuber yield (t ha^{-1})
T_1 : Recommended dose of nutrients of 25 t FYM ha^{-1}+ 75:75:100 kg of NPK ha^{-1}.	139.3	5.1	3.8	5.0	5.3	2.9	17.1
T_2 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CU foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	122.2	4.3	3.8	4.9	4.2	1.7	14.8
T_3 : 50 per cent RDN through FYM + 50 per cent RDVN through C, fb FBM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	108.1	4.2	3.2	4.9	4.8	1.5	14.5
T_4 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb 5 per cent BOC foliar spray at 30, 45, 60 DAP.	98.0	3.8	3.5	4.8	4.5	0.5	12.3
T_5 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb 0.5 per cent silica foliar spray at 30, 45, 60 DAP.	103.8	3.9	3.3	4.6	4.8	1.3	14.2
T_6 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CT foliar spray at 30, 45, 60 DAP (500 l ha^{-1}).	111.8	4.2	3.5	4.8	4.4	1.9	14.7
T_7 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb PG foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	134.7	4.9	3.4	3.4	5.2	2.9	16.5
T_8 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb JM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	130.4	4.8	3.3	4.7	5.1	2.7	15.9
T_9 : 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CU + FBM foliar spray at 30 DAP, fb PG + JM foliar spray at 45 DAP, fb 5 per cent BOC + CT foliar spray at 60 DAP.	127.2	4.3	3.1	4.6	4.9	2.7	15.5
S.Em. ±	9.5	0.3	0.3	0.2	0.3	0.1	0.7
CD (P = 0.05)	NS	NS	NS	0.8	NS	0.4	2.1

Note: VC: Vermicompost, fb: Followed by, CU: cow urine, FBM: Fermented butter milk, BOC: Biofuel oil cake solution, CT: Compost tea, PG: Panchagavya, JM: Jeevamrutha, RDN: Recommended dose of nitrogen

Tuber Grading

Grades of potato were significantly influenced by spraying of different organic nutrient solutions in potato. The results are presented in Table 3 and depicted in Fig 1.

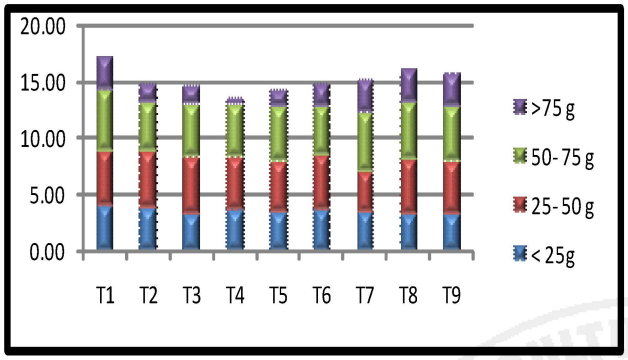

Fig.1: Effect of organic nutrients sources on different grades of potato

'D' Grade (< 25 g)

Higher 'D' grade tuber yield (3.8 t ha^{-1}) was recorded with recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1}. Lower number of 'D' grade tuber yield was recorded in 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by cow urine + butter milk foliar spray at 30 DAP, followed by panchagvya + jeevamrutha foliar spray at 45 DAP, followed by 5 per cent bio-fuel oil cake + compost tea foliar spray at 60 DAP (3.1 t ha^{-1}).

'C' Grade (25 - 50 g)

Significantly higher 'C' grade tuber yield (5.0 t ha^{-1}) was observed with application of recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1}, which was on par with 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by cow urine foliar spray at 30, 45 and 60 DAP (4.9 t ha^{-1}) and 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by fermented butter milk foliar spray at 30, 45 and 60 DAP (4.9 t ha^{-1}). This was followed by 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, and panchagavya foliar spray at 30, 45, 60 DAP was recorded significantly lower C sized tuber yield (3.4 t ha^{-1}).

'B' Grade (50-75 g)

Higher 'B' grade tuber yield (5.3 t ha^{-1}) was observed in recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1}. While, 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by cow urine foliar spray at 30, 45 and 60 DAP which recorded lower 'B' sized tuber yield (4.2 t ha^{-1}).

'A' Grade (> 75 g)

Significantly higher 'A' grade tuber yield (2.9 t ha^{-1}) was observed in recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} and 50 per cent RDN through FYM + 50 per cent RDN through VC, fb PG foliar spray at 30, 45 and 60 DAP (1:1 dilution with water) followed by 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost. This was followed by panchagavya foliar spray at 30, 45 and 60 DAP (2.9 t ha^{-1}) and 50 per cent RDN through FYM + 50 per cent RDN through VC, fb CU + FBM foliar spray at 30 DAP, fb PG + JM foliar spray at 45 DAP, fb 5 per cent BOC + CT foliar spray at 60 DAP. The lowest 'A' grade tuber was recorded in 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45, 60 DAP recorded significantly lower 'A' grade tuber yield (0.5 t ha^{-1}). Grades of potato was significantly higher in application of recommended dose of nutrients of 25t FYM ha^{-1} + 75:75:100 Kg of NPK ha^{-1} with respect to A, B, C and D grade (2.9, 5.3, 5.0 and 3.8 t ha^{-1} respectively) compared to other treatments. This might be due to the combined effect of fertilizer and FYM. In this treatment application of fertilizer along with FYM was matched with crop demand and input supply. The increase in size pertaining to different grade may be attributed to improvement in the growth components such as plant height, number of shoots, number of leaves plant^{-1}, leaf area and total dry matter. 'N' has the greatest impact on potato yield formation among all essential macronutrients (Silva *et al.* 2013). Potato yield can be divided into the three components: 'number of stems per square meter', 'number of tubers per stem' and 'average tuber weight', where N has the greatest impact on the average tuber weight is a

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structural component of nucleic acids as units in deoxyribonucleic acid and ribonucleic acid molecules of many coenzymes and of phospholipids in bio-membranes (Rosen *et al.,* 2014). Economically speaking, P has a significant impact on the setting of potato tubers, especially in the early growth states (Hopkins *et al*., 2014), but also at later growth stages where P enhances tuber maturity (Rosen *et al*., 2014).

Tuber Yield (t ha^{-1})

Application of recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} recorded significantly higher tuber yield (17.1 t ha^{-1}), closely followed by 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by panchagavya foliar spray at 30, 45, 60 DAP (16.5 t ha^{-1}) and 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by jeevamrutha foliar spray at 30, 45, 60 DAP (15.9 t ha^{-1}). While, recorded significantly lower tuber yield (12.3 t ha^{-1}) with 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45, 60 DAP.

Crop yield is controlled by the interaction between the genetic potentialities of crop plants and the environment in which they grow. Variations in the genotype and in the environment, including weather and cultural practices, act through physiological processes to control growth. Thus, the physiological processes of plants are the machinery through which both the genetic potentialities and the environment operate to produce the quantity and quality of growth or phenotype. Application of recommended dose of nutrients of 25t FYM ha^{-1} +75:75:100 kg of NPK ha^{-1} produced significantly higher tuber yield of potato (17.1 t ha^{-1}). Significantly lower tuber yield (12.3 t ha^{-1}) was observed in application of 50 per cent RDN through FYM + 50 per cent RDN through vermi-compost, followed by 5 per cent bio-fuel oil cake foliar spray at 30, 45, 60 DAP. The higher yield recorded might be due to the fact that nitrogen and phosphorus play an important role in the synthesis of chlorophyll and amino acids. Fertilizer addition ensures the more availability and uptake of plant nutrients. Application of fertilizer at right time and in right quantity in right place will meet the crop nutrient demand at right time so, it ultimately resulted in higher yield. Application of FYM besides supplying N, P_2O_5 and K_2O also supplies micro nutrients and improved the soil condition, which enhanced the root proliferation and source to sink relationship. Increase in yield in these treatments may also be attributed to synergistic effect of combined use of fertilizer and FYM.

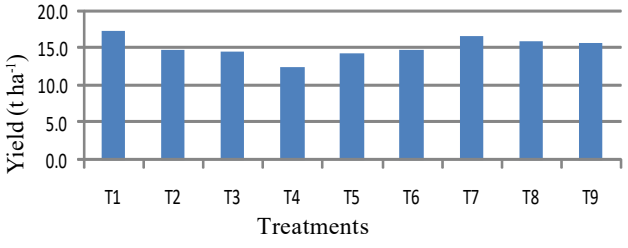

Fig.2 : Effect of organic nutrients sources on tuber yield of potato

Economics

Economics of potato as influenced by organic nutrient sprays are presented in Table 4. The higher gross returns and net returns (215237 and 148879 Rs.ha^{-1}) were recorded in the treatment with application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by panchagavya foliar spray at 30, 45, 60 DAP, closely followed by 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by jeevamrutha foliar spray at 30, 45, 60 DAP (207350 and 141322 Rs.ha^{-1}) and lower gross returns and net returns (160333 and 94306 Rs.ha^{-1}) was noticed in the treatment with 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by 5 per cent biofuel oil cake foliar spray at 30, 45, 60 DAP.

The higher B:C ratio (2.24) was recorded in the treatment with 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by panchagavya foliar spray at 30, 45, 60 DAP, closely followed by treatments *viz*., application of 50 per cent RDN through FYM + 50 per cent RDN through vermicompost, followed by jeevamrutha foliar spray at 30, 45, 60 DAP and recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} (2.14 and 2.14 respectively) and lower B:C ratio (1.43) was noticed in the treatment with 50 per cent RDN through

TABLE 4

Economics in potato as influenced by different organic nutrient sources in potato

Treatments	Tuber yield (t ha-1)	Cost of cultivation (Rs. ha-1)	Gross returns (Rs. ha-1)	Net returns (Rs. ha-1)	B:C
T_1 = Recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1}.	17.1	65568.00	205560	139992	2.14
T_2 = 50% RDN through FYM + 50% RDN through VC, fb CU foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	14.8	65896	192660	126764	1.92
T_3 = 50% RDN through FYM + 50% RDVN through C, fb FBM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	14.5	66093	189280	123186	1.86
T_4 = 50% RDN through FYM + 50% RDN through VC, fb 5% BOC foliar spray at 30, 45, 60 DAP.	12.3	66028	160333	94306	1.43
T_5 = 50% RDN through FYM + 50% RDN through VC, fb 0.5% silica foliar spray at 30, 45, 60 DAP.	14.2	66093	184643	118551	1.79
T_6 = 50% RDN through FYM + 50% RDN through VC, fb CT foliar spray at 30, 45, 60 DAP (500 l ha^{-1}).	14.7	65962	192097	126135	1.91
T_7 = 50% RDN through FYM + 50% RDN through VC, fb PG foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	16.5	66358	215237	148879	2.24
T_8 = 50% RDN through FYM +50% RDN through VC, fb JM foliar spray at 30, 45, 60 DAP (1:1 dilution with water).	15.9	66028	207350	141322	2.14
T_9 = 50% RDN through FYM +50% RDN through VC, fb CU + FBM foliar spray at 30 DAP, fb PG + JM foliar spray at 45 DAP, fb 5% BOC + CT foliar spary at 60 DAP.	15.5	66061	202670	136609	2.07

Note : VC: Vermicompost, fb: Followed by, CU: cow urine, FBM: Fermented butter milk, BOC: Biofuel oil cake solution, CT: Compost tea, PG: Panchagavya, JM: Jeevamrutha,RDN: Recommended dose of nitrogen

FYM + 50 per cent RDN through Vermicompost, followed by 5 per cent biofuel oil cake foliar spray at 30, 45, 60 DAP.

From the study it can be inferred that recommended dose of nutrients of 25 t FYM ha^{-1} + 75:75:100 kg of NPK ha^{-1} has registered significantly higher growth, yield attributes and tuber yield followed by 50 per cent RDN through FYM + 50 per cent RDN through VC, fb panchagayya foliar spray at 30, 45, 60 DAP (1:1 dilution with water) are found to be best treatments for adoption.

REFERENCES

HOPKINS, B. G., HORNECK D. A. AND MACGUIDWIN, A. E., 2014, Improving phosphorus use efficiency through potato rhizosphere modification and extension. *Am. J. Potato Res.,* **91** : 161 - 174.

OSPINA, C. A., LAMMERTS VAN BUEREN, E. T., ALLEFS JJHM, ENGEL, B., VAN DER PUTTEN PEL, VAN DER LINDEN, C. G. AND STRUIK, P. C., 2014, Diversity of crop development traits and nitrogen use efficiency among potato cultivars grown under contrasting nitrogen regimes. *Euphytica.,* **199** : 13 - 29.

RICHAKHANNA, 2013, Effect of precision nutrient and water management with different sources and levels of fertilizers on maize production. *M.Sc. (Agri.) Thesis* (Unpub.), University of Agril. Sciences, Bangalore.

ROSEN, C. J., KELLING K. A., STARK, J. C. AND PORTER, G. A., 2014, Optimizing phosphorus fertilizer management in potato production. *Am. J. Potato Res.,* **91** : 145 - 160.

SILVA, J. G., FRANCA, M. G. C., GOMIDE, F. T. F. AND MAGALHAES, J. R., 2013, Different nitrogen sources affect biomass partitioning and quality of potato production in a hydroponic system. *Am. J. Potato Res.,* **90** : 179 - 185.

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