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Impact of inorganic and organic sources on bio-growth and nutrient accumulation in tomato crop cv. H-86 (Kashi Vishesh)

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Abstract
An investigation was carried out on "Impact of inorganic and organic sources on bio- growth and nutrient accumulation in tomato crop*"*. The experiment was conducted in split plot design having two main plot (farmyard manure and pressmud compost), five subplot level of treatment (0, 5 10, 15, 20 MT ha^{-1} organic manure along with RDF) with replicated thrice. Result revealed that highest fruit length and fruit diameter was recorded in the treatment T_3 (T_0 + 15 MT ha^{-1} organic manure) which was at par with the treatment T_4 (T_0 + 20 MT ha^{-1} organic manure). Whereas, significantly highest fruit yield (863.2 q ha^{-1}) was recorded in the treatment T_4 (T_0 + 20 MT ha^{-1} organic manure) which was 21.5 and 31.70 per cent higher over T_1 (T_0 + 5 MT ha^{-1} organic manure) and T_0 (Recommended dose of fertilizer), respectively. Maximum nitrogen (4.94%) and phosphorus (0.46%) content in fruit was found significant in the treatment T_4 (T_0+ 20 MT ha^{-1} organic manure), whereas the potassium content was observed maximum in treatment T_4 (4.25%). Significantly higher uptake of nitrogen (237 kg ha^{-1}), phosphorus (22.1 kg ha^{-1}) and potassium (204.7 kg ha^{-1}) in fruit was observed in treatment T_4 (T_0+ 20 MT ha^{-1} organic manure). Overall results indicated that combined application of inorganic and organic sources of farmyard manure and pressmud compost improve the nutrients content, uptake and bioaccumulation capacity and ultimately sustain the yield of tomato crop.

Keywords: inorganic source, organic sources, nutrient content and uptake

Introduction
Use of inorganic fertilizer alone increased the crop yield in the initial year but adversely affected the sustainability at the later stage of crop production. Application of organic manures improves the soil fertility and enhance yield (Abdullah and Lombin, 1978; Lombin, 1991) [1]. Supplementation with organics certainly improves the soil health as well as increases the yield. Manure is suitable source of nutrients for improving performance of tomato especially when combined with NPK fertilizer to combine the attributes of the two materials (Awosika *et al.* 2014, Singh *et al.* 2010) [2, 21] Studies conducted by Barker (1975), Clarke and Marrow (1979) on marketable yields and quality factors of vegetables grown under organic and inorganic soil management indicated a positive response to the various sources of nutrition [3, 7]. Use of organic nutrients along with inorganic sources, not only helpful in increasing the yield and quality of the crop but also act as storehouse of nutrients for successive crop besides improving the physical properties of soil. Organic amendment affects soil properties in numerous and variable ways. These effects can be due to intrinsic properties of the organic amendment (direct effect) or as a consequence of beneficial effect of the organic amendment on physical, chemical and biological properties of soil (Tejada *et al.*, 2006, 2009) [23, 24] Keeping above facts in mind, a scientific study was conducted to understand the effect of farmyard manure and pressmud compost along with RDF on growth, yield and yield attributing characters, as well as to assess the concentration and uptake of nutrients of tomato crop.

Material and Methods
The field experiment was conducted at Vegetable Research Farm of Bihar Agricultural University, Sabour, Bhagalpur during *rabi* season in the year 2015-16. It is located in South Bihar Alluvial Plain Zone *i.e.* the Agro climatic Zone III A of Bihar by National Agricultural Research Project in Bhagalpur district. Geographically it is located at 25°50' N latitude and 87°19' E longitude at an altitude of 52.73 meters above mean sea-level (MSL) in the heart of vast Indo-Gangetic plains of North India. The climate is Sub-tropical in nature having dry

summer, moderate rainfall and very cold winter. During growing season, the maximum and minimum temperatures were recorded approx 31.5 ºC and 7.6 ºC respectively.

The experimental plot was well drained, having sandy loam soil texture with good fertility status (organic carbon- 5.3 g kg^{-1}, available nitrogen- 162.6 kg ha^{-1}, available P_2O_5- 43.1 kg ha^{-1} and available K_2O- 167.2 kg ha^{-1}) fall under *Typic Haplustepts*. The experiment was laid out in split plot design with two main plot treatment and having five subplot treatment *i.e.* T_0= Control Recommended dose of fertilizer, T_1= T_0+ 5 MT ha^{-1} organic manure, T_2=T_0+ 10 MT ha^{-1} organic manure, T_3= T_0+ 15 MT ha^{-1} organic manure, T_4= T_0+ 20 MT ha^{-1} organic manure with replicated thrice and variety *Kashi Vishesh* (H-86) has been selected for test crop. The main plot was divided into 30 subplots having net plot size 3.0m X 2.7m. The farmyard manure and pressmud compost were applied 20 days before transplanting the seedlings. Nursery bed was irrigated one day prior to transplanting in order to facilitate uprooting of seedlings. Row to row and plant to plant distance were kept 60 cm and 45 cm, respectively. The one third of recommended dose of nitrogen and full dose of P_2O_5 ha^{-1} and K_2O ha^{-1} were applied through urea, single super phosphate and muriate of potash respectively at the time of transplanting as basal, rest of nitrogen was applied top dress in two equal splits at 25 and 45 days after transplanting. Five plants were randomly selected in each net plot area for taking observation on growth and yield attributing parameters. The fruit in each net plot are harvested separately and the values were converted into hectare and expressed in quintals per hectare. Tomato fruits were collected at maturity and after processing used for analysis of total nitrogen, phosphorus and potassium. Nitrogen contents were estimated by modified micro-kjeldhal's method as outlined by Jackson (1973) [11] Phosphorus contents were estimated by vanadomolybdate phosphoric yellow colour method as outlined by Jackson (1973) [11] and Potassium was estimated by wet digestion method as described by Jackson (1973) [11]. The data collected for all the characters involved under study was statistically analysed by Split Plot design followed by Panse and Sukhatme (1967) for proper interpretation [17].

Results and Discussion

Effect of organic sources on growth and yield attributes

plant height

The results revealed that effect of organic level was clearly observed and found higher in pressmud compost treated plot compared to farmyard manure treated plot. Results indicated that T_3 (T_0 + 15 MT ha^{-1} organic manure) was recorded highest plant height. The overall results were non-significant in respect of plant height (Table 1). It might be due to quick and readily availability of major nutrients like N, P and K to plants at earlier stages for plant growth and helps to increase the activity of cell division, expansion and elongation, ultimately more utilization of major nutrients leading to increased plant height. These results were corroborated by Rodge and Yadlod (2009) and Gosavi *et al.* (2010) in tomato crop [19, 10].

Fruit length

Influence of inorganic and organic sources on fruit length revealed that the treatment T_3 (T_0 + 15 MT ha^{-1} organic manure) recorded highest fruit length and was at par with the treatment T_4 (T_0+ 20 MT ha^{-1}organic manure). The treatment T_3 was significantly higher by 17.3%, 11.9% and 8.6% over To (Recommended dose of fertilizer), T_1 (T_0+ 5 MT ha^{-1} organic manure) and T_2 (T_0+10 MT ha^{-1} organic manure) respectively. In case of organic sources, the pressmud compost treated plot had slightly higher fruit length than farmyard manure treated plot (Table 1). Results clearly indicate there was a positive effect of graded doses of organic manure on fruit length of tomato. The might be due to favourable effect of the organic manure in supplying essential nutrients in balanced ratio and improving physical, chemical and biological properties of soil helps in better nutrients absorption and utilization by plant resulting in higher value of yield and yield attributing characters. The result is in conformity with Chumyani *et al.* (2012) [6].

Fruit diameter

The data presented in the Table 1 clearly indicate the treatment T_3 (T_0+ 15 MT ha^{-1} organic manure) and T_4 (T_0+ 20 MT ha^{-1} organic manure) recorded highest fruit diameter and were 10.9% significantly higher than T_0 (Recommended dose of fertilizer). The pressmud compost treated plot recorded slightly higher fruit diameter than farmyard manure treated plot but the effect was statistically non-significant. The result indicated that there was positive effect of graded doses of organic manure on fruit diameter of the plant. It might be due to higher vegetative growth of the plant that helps in the synthesis of greater amount of food material and are translocated into developing fruits resulting in increased fruit length and fruit diameter (Chumyani *et al*., 2012) [6].

Table 1: Effect of Farmyard manure and Pressmud compost on plant height, fruit length and fruit diameter of tomato crop

Organic sources / Treatments		Plant height (cm)			Fruit length (mm)			Fruit diameter (mm)			yield (q ha^{-1})		
		Farmyard manure	Pressmud	Mean	Farmyard manure	Pressmud	Mean	Farmyard manure	Pressmud	Mean	Farmyard manure	Pressmud	Mean
T_0		102.3	103.7	103.0	50.1	50.2	50.1	60.0	60.4	60.2	656.3	654.5	655.4
T_1		104.7	115.0	109.8	53.2	52.4	52.8	61.9	61.9	61.9	695.8	724.9	710.3
T_2		105.0	114.0	109.5	54.2	54.7	54.4	62.0	62.8	62.4	731.4	766.0	748.7
T_3		105.7	114.3	110.0	58.6	59.6	59.1	66.7	66.9	66.8	842.2	851.5	846.8
T_4		110.7	107.7	109.2	58.2	59.5	58.8	66.8	66.9	66.8	857.2	869.3	863.2
Mean		105.6	110.9		54.86	55.28		63.48	63.78		756.58	773.24	
LSD (p=0.05)	M	NS			NS			NS			NS		
	S	NS			4.9			5.5			124.4		
	MXS	NS			NS			NS			NS		

Yield

The fruit yield was significant in treatments whereas it was non-significant in organics and interaction. The positive effect on yield with recommended dose of inorganics and graded doses of organics is clearly seen; as the doses of organics increased the yield was also increased. The pressmud compost

treated plot was recorded higher fruit yield as compared to farmyard manure treated plot. The treatment T_4 (To+ 20 MT ha^{-1}organic manure) recorded significantly higher fruit yield i.e. 31.7% and 21.5% higher over T_0 (Recommended dose of fertilizer) and T_1 (T_0+ 5 MT ha^{-1}organic manure) respectively. The effect of organic manure on yield might be due to prevailing better soil condition and increased availability of nutrients, which enhanced the uptake of nutrients resulting in improved yield. The finding of Kavitha and Rao (2010) revealed that the organic manure not only contains sufficient nutrients but the nutrients are slowly released to the plants [12] This prevents nutrients loss and leaching, as well as improving nutrient use efficiency. All these facilitate higher production of economic part of the plants. These organic manures also enhance microflora population in soil and hence have solubilizing effect on nutrient and make it available to crop. Similar results were found by Manolikar *et al.* (2007), Parry *et al.* (2007), Taiwo *et al*. (2007), Narayan *et al*. (2008) [15, 18, 22, 16].

Effect of organic sources on nutrient content

Nitrogen content

The concentration of nitrogen was highest in treatment T_4 (T0+ 20 MT ha-1 organic manure) which was at par with treatment T_3 (T_0+ 15 MT ha^{-1} organic manure). This treatment was significantly higher by 29.6%, 19.0% and 11.7% over T0 (Recommended dose of fertilizer), T_1 (T_0+ 5 MT ha^{-1} organic manure) and T_2 (T_0+ 10 MT ha^{-1} organic manure), respectively. The result (Table 2) showed that nitrogen content in fruit of tomato increased significantly by the application of graded doses of organic manure due to uninterrupted supply of nitrogen from organics and native soil through activation of microflora.

Phosphorus content

The concentration of phosphorus was highest in the treatment T_4 (T_0+ 20 MT ha^{-1} organic manure) and was at par with treatment T_3 (T_0+ 15 MT ha^{-1} organic manure). This treatment was significantly higher by 43.7%, 31.4% and 21.05% over T_0 (Recommended dose of fertilizer), T_1 (T_0+ 5 MT ha^{-1} organic manure) and T_2 (T_0+ 10 MT ha^{-1} organic manure), respectively. The result (Table 2) revealed that phosphorus content in tomato plant increased significantly by the application of graded doses of organic manure in soil through activation of microflora, organic manure that have increased the availability and solubility of phosphorus by contributing organic acids and growth hormone like auxin and cytokinin which might have mobilized the soil phosphorus to the plant and enhanced the phosphorus content in plants, reported by Chatterjee and Bandyopadhyay (2014) [4].

Table 2: Effect of Farmyard manure and Pressmud compost on fruit macronutrient concentration of tomato crop

		Nitrogen (%)			Phosphorus (%)			Potassium (%)		
Organic sources / Treatments		Farmyard manure	Pressmud	Mean	Farmyard manure	Pressmud	Mean	Farmyard manure	Pressmud	Mean
T_0		3.80	3.83	3.81	0.32	0.33	0.32	3.69	3.92	3.80
T_1		4.06	4.24	4.15	0.35	0.35	0.35	3.91	4.01	3.96
T_2		4.38	4.47	4.42	0.37	0.38	0.38	4.02	4.10	4.06
T_3		4.74	4.77	4.76	0.40	0.47	0.43	4.05	4.19	4.12
T_4		4.90	4.98	4.94	0.42	0.50	0.46	4.26	4.23	4.25
Mean		4.41	4.48		0.37	0.40		3.98	4.09	
LSD (p=0.05)	M	NS			NS			NS		
	S	0.39			0.03			NS		
	MXS	NS			NS			NS		

Potassium content

While in case of potassium the treatment T_4 (T_0+ 20 MT ha^{-1} organic manure) contained higher potassium than all other treatment and the pressmud compost treated plot leads to slightly higher fruit potassium than farmyard manure treated plot. However, the overall effect was non-significant on fruit potassium content was observed (Table 1). The application of chemical fertilizers alone or in combination with organic manures increased the nutrient content over control due to better supply of nutrients through organic manures (Sharma and Samnotara, 2009) [20].

Effect of organic sources on nutrient uptake

Nitrogen uptake

The uptake of nitrogen was highest in the treatment T_4 (T_0+ 20 MT ha^{-1} organic manure) and was significantly higher by 53.8%, 38.5%, 24% and 10.7% over T_0 (Recommended dose of fertilizer), T_1 (T_0+ 5 MT ha_{-1} organic manure), T_2 (T_0+ 10 MT ha^{-1} organic manure) and T_3 (T_0+ 15 MT ha^{-1} organic manure), respectively (Table 3). Similar to yield and concentration of nutrients, the uptake of nitrogen was significant because of uninterrupted supply of nitrogen from organics and native soil through activation of microflora. The organic sources have effect on dry matter production of tomato by better availability of nutrients by their decomposition and this led to increase in nutrient uptake by crop. The increased total dry matter production and nutrient content in plants seems to be the major causes responsible for the higher uptake under the influence of integrated nutrient management was reported by Choudhary *et al*., 2011 and Kumari (2010) [5, 13].

Table 3: Effect of Farmyard manure and Pressmud compost macronutrient uptake in fruit of tomato crop

Nutrients	Nitrogen (Kg ha^{-1})			Phosphorus (Kg ha^{-1})			Potassium (Kg ha^{-1})		
Organic sources / Treatments	Farmyard manure	Pressmud	Mean	Farmyard manure	Pressmud	Mean	Farmyard manure	Pressmud	Mean
T_0	153	155	154	13.1	13.2	13.2	148.2	157.5	152.9
T_1	167	176	171	14.5	14.8	14.6	160.5	166.8	163.6
T_2	186	195	191	15.8	16.9	16.4	170.0	180.0	175.0

T_3		209	219	214	17.5	21.6	19.6	178.3	192.7	185.5
T_4		235	239	237	20.3	24.0	22.1	205.2	204.2	204.7
Mean		191	198		16.2	18.1		172.4	180.2	
LSD(p=0.05)	M	NS			NS			NS		
	S	18			1.5			28.7		
	MXS	NS			2.1			NS		

Phosphorus uptake

The uptake of phosphorus by fruits was the highest in treatment T_4 (T_0+ 20 MT ha^{-1} organic manure) and was significantly higher by 67.4%, 51.3%, 34.7% and 12.7% over T_0 (Recommended dose of fertilizer), T_1 (T_0+ 5 MT ha^{-1} organic manure), T_2 (T_0+ 10 MT ha^{-1} organic manure) and T_3 (T_0 + 15 MT ha^{-1} organic manure) respectively, whereas in case of interaction the treatment T_4 (T_0+ 20 MT ha^{-1} organic manure) of pressmud compost treated plot recorded higher phosphorus uptake and it was significantly higher by 18.22% over T_4 (T_0+ 20 MT ha^{-1} organic manure) of farmyard manure treated plot. This same treatment was 11.11% and 37.14% significantly higher by treatment T_3 (T_0+ 15 MT ha^{-1} organic manure) of pressmud compost treated plot and farmyard manure treated plot respectively (Table 2). This might be due to the decomposition of organic manures is accompanied by the release of appreciable quantities of CO_2 which gets dissolved in water to form carbonic acid. Carbonic acid is capable of decomposition of certain primary minerals and release of nutrients and favours higher biomass production and nutrient uptake. Further, CO_2 plays an important role in the solubilisation of native P and reduce phosphate fixing capacity of the soil. These actions of organic manures resulted in higher uptake of phosphorus. Similar results were corroborated by Ewulo *et al* (2008) and Kumari (2010) [9, 13].

Potassium uptake

The uptake of potassium was highest in the treatment T_4 (T_0+ 20 MT ha^{-1} organic manure) which was at par with treatment T_3 (T_0+ 15 MT ha^{-1} organic manure), and significantly higher by 33.8%, 25.12% and 16.9% over the treatment T0 (Recommended dose of fertilizer), T_1 (T_0+ 5 MT ha^{-1} organic manure) and T_2 (T0+ 10 MT ha^{-1} organic manure) respectively. The significant uptake of K might be due to addition of K to the available pool of the soil, besides reduction of K fixation and release of K due to interaction of organic manure with clay. Dubey *et al.* (2012) found that the integrated application of organic manures and inorganic sources of nutrients significantly increased the uptake due to increased supply of all essential nutrients directly through organic and inorganic source to crop, indirectly through checking the losses of nutrients from soil solution and by increasing the nutrient use efficiency [8]. Nutrient uptake by the crop depends primarily on the dry matter accumulation and secondarily on the nutrient content at cellular level. Similar to yield and concentration of nutrients, the uptake of nutrients in fruits also significantly increased with increasing the dose of organics this might be due to their inherent capability to supply nutrients during the crop growth period, which in turn influence the dry matter production and hence nutrients uptake by plants. The application of organic manure also improved the physical properties of soil which led to improved uptake of nutrients. Application of organic manures along with NPK increased the uptake because of increase in availability of nutrients to plants and proliferous root system developed under balanced nutrient application resulting in better absorption of water and nutrients. Organic manures also supply major and minor nutrients along with organic acids and provided good soil physical condition for plant growth which increased the uptake of nutrients. Similar results were corroborated by Kumari (2010) and Choudhary *et al.* (2011) [13, 5].

Conclusion

Based on the finding of field experiment it can be concluded that the application of 15 MT ha^{-1} organics along with the recommended dose of fertilizer improved the growth and yield of tomato crop as well as increased the nutrient concentration and uptake compared to control (recommended dose of fertilizers), which enhanced the essential nutrients in the soil. Therefore, addition of farmyard manure and pressmud compost along with mineral fertilizer made more nutrients available to tomato crop.

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