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Effect of integrated nutrient management on NPK availability in soil and their uptake by ridge gourd [*Luffa acutangula* L. (Roxb.)]

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Abstract
An experiment was conducted to find out the effect of integrated nutrient management on nutrient availability in soil and their uptake by ridge gourd [*Luffa acutangula* L. (Roxb.) during summer (zaid), 2017 and 2018. Treatment of experiment includes three levels of NPK (75,100 and 125 % RDF), two organic manures (FYM @ 20 t/ha and vermicompost @ 8.3 t/ha) and four biofertiilizers (No inoculation, inoculation with *Azotobactor*, PSB and *Azotobactor* + PSB). The results illustrated that application of 125 % NPK being at par to 100 %, Vermicompost and Bio-fertilizers (*Azotobactor* +PSB) have recorded maximum nutrient concentration in plant and their availability in soil and uptake of by plant. Hence, the treatment 100% NPK, VC and BF (*Azotobactor* + PSB) are considered as a best treatment for ridge gourd crop.

Keywords: Available NPK in soil, NPK uptake, biofertiilizers, vermicompost, Ridge gourd

Introduction
Luffa [*Luffa acutangula* L. (Roxb.)] is commonly called as ridge gourd and it is the member of the cucurbitaceae family, grown for its edible immature green fruits. It has great demand in local market among fresh vegetables due to its availability in summer and rainy season. Ridge gourd is highly fertilizer responsive crop due to its maximum returns. Among the nutrients required by the crop, nitrogen is the most deficient element especially in coarse textured sandy soil of Rajasthan. Availability of nitrogen is important for growing plants as it is major indispensable constituent of protein and nucleic acid. The application of different doses of nitrogen (N) fertilization increased plant growth and yield (Wahocho *et al*., 2017 [15] Phosphorus is necessary for cellular preparation and in the metabolism of starch, protein and fats. One of the most important effects of phosphorus on plants is the stimulation of early root formation and growth. Low available phosphorus content in soil means delay in maturity and poor plant growth (Meena *et al*., 2017) [5]. Potassium (K) is the nutrient having the strongest influence on plant growth, yield and quality attributes that determine fruit marketability (Lester *et al*., 2007) [4]. Its role in plant metabolism, growth and development and its significance in production of marketable fruit and on fruit firmness, quality and visual appearance are well known (Al-Moshileh *et al*., 2005) [1]. Although fertilizer support the crop production but continuous application of the heavy doses of fertilizers leads to damages the natural ecology, nutrient recycling and the biological activities in soil (Prasad *et al*., 2009) [11]. The information on effect of INM on nutrient availability in soil and nutrient uptake by ridge gourd crop was inadequate. Therefore, present experiment was carried out to study the influence of integrated nutrient management on nutrient availability and their nutrient uptake by ridge gourd cv. Pusa Nutan.

Materials and Methods
This experiment was carried out at Horticulture farm, SKN College of Agriculture, Sri Karan Narendra Agriculture University, Jobner during *Zaid* (summer) seasons of 2017 and 2018to study the influence of integrated use of inorganic, organic manures and bio fertilizers on nutrient availability in soil and their uptake by ridge gourd cv. Pusa Nutan. The field was loamy sand having pH 8.2 with poor organic carbon (0.18 %) and the plot size 5.0 X 2.5 m with a spacing of 2.5 m X 0.5 m. The experiment was laid out in factorial randomized block design with three replications. The treatments were three levels of inorganic fertilizers (75%, 100% and 125 % RD of NPK), two organic manures (FYM @ 20 t/ha and vermicompost @

8.3 t/ha) and four Bio-fertilizers (No inoculation, inoculation with *Azotobactor*, PSB and *Azotobactor*+ PSB). The recommended dose of NPK for ridge gourd crop is 100:40:40 kg ha^{-1}. Full dose of P as single super phosphate and K as Muriate of potash and half dose of N as urea was applied on the day of sowing and rest of half dose of N at 25 DAS. *Azotobactor* and PSB was applied as seed treatment @ 70 ml kg^{-1} of seed. Farm yard manure and vermicompost were applied as per treatment schedule. Regular weeding, earthing up, irrigation and plant protection measures were followed as per recommended practices. The available N content in soil was determined by alkaline permanganate method (Subhiah and Asija, 1956), available P content by Olsen method (Olsen *et al.*, 1954)and available K was determined by extraction of soil with 1N neutral ammonium acetate and estimated by flame photometer (Metson, 1956) [6]. Uptake of nitrogen, phosphorus and potassium was computed from nitrogen, phosphorus and potassium content in plant and yield of fruit by using the following relationship.

$$\text{Uptake of NPK (kg/ha)} = \frac{\text{\% NPK content in plant x fruit yield(kg/ha)}}{100}$$

Results and Discussion

The results of the pooled data of the experiment on nutrient content (Table 1), available nutrient in soil (Table 1) and nutrient uptake by plant (Table 2) were presented as influenced by integrated nutrient management during zaid (summer) season 2017 and 2018. Significant effect of integrated nutrient management was observed on N, P and K content in plant and their availability in soil (Table 1).

Table 1: Effect of INM on NPK content in plant and their availability in soil

	NPK content in plant (%)			Available NPK in soil (kg/ha)		
Treatments	**N**	**P**	**K**	**N**	**P**	**K**
Inorganic fertilizers						
F_1 (75 % RD of NPK)	1.187	1.282	1.282	76.12	9.32	122.21
F_2 (100 % RD of NPK)	1.334	1.391	1.376	83.36	9.94	130.10
F_3 (125 % RD of NPK)	1.353	1.435	1.384	85.64	10.22	133.31
SEm±	0.017	0.018	0.018	1.06	0.13	1.74
CD (P=0.05)	0.047	0.051	0.051	2.99	0.37	4.87
Organic manures						
M_1 (FYM @ 20 t/ha)	1.228	1.316	1.308	78.24	9.52	124.73
M_2 (Vermicompost @ 8.3 t/ha)	1.354	1.423	1.386	85.18	10.13	132.35
SEm±	0.014	0.015	0.015	0.87	0.11	1.42
CD (P=0.05)	0.038	0.041	0.042	2.44	0.30	3.98
Bio-fertilizers						
B_0 (No inoculation)	1.245	1.326	1.337	77.56	8.94	127.00
B_1 (*Azotobactor)*	1.328	1.335	1.350	83.17	9.52	128.85
B_2 (PSB)	1.255	1.388	1.343	80.43	10.22	128.33
B_3 (*Azotobactor* + PSB)	1.338	1.430	1.359	85.69	10.63	129.99
SEm±	0.019	0.021	0.021	1.23	0.15	2.00
CD (P=0.05)	0.054	0.059	NS	3.45	0.42	NS

Table 2: Effect of INM on N, P and K uptake by ridge gourd

	NPK uptake (kg/ha)		
Treatments	**N**	**P**	**K**
Inorganic fertilizers			
F_1(75 % RD of NPK)	101.16	109.08	108.78
F_2(100 % RD of NPK)	160.51	167.12	165.20
F_3(125 % RD of NPK)	167.55	177.78	170.94
SEm±	2.92	3.75	3.10
CD (P=0.05)	8.21	10.52	8.70
Organic manures			
M_1(FYM @ 20 t/ha)	124.01	132.38	131.18
M_2(Vermicompost@ 8.3 t/ha)	162.14	170.28	165.43
SEm±	2.39	3.06	2.53
CD (P=0.05)	6.70	8.59	7.10
Bio-fertilizers			
B_0(No inoculation)	126.25	134.05	134.96
B_1(*Azotobactor)*	149.47	149.85	151.08
B_2(PSB)	139.33	153.68	148.31
B_3(*Azotobactor* + PSB)	157.25	167.73	158.87
SEm±	3.37	4.32	3.58
CD (P=0.05)	9.48	12.15	10.04

Inorganic fertilizers

Among inorganic fertilizers, the highest N content in plant, its availability in soil and uptake by plant was observed with the 125 % RDF (1.353 %, 85.64 kg/ha and 167.55 kg/ha, respectively) being statistically at par with 100 % RDF. Similarly maximum Pconcentration in plant, availability in soil and its uptake by plant (1.435 %, 10.22 kg/ha and 177.78 kg/ha, respectively) was recorded in 125 % RDF (F_3) followed by 100 % RDF, being statistically at par with each other whereas, minimum P concentration (1.282 %, 9.32 kg/ha and 109.08 kg/ha, respectively) in 75 % RDF (F_1). Plants fertilized with 125 % RDF followed by 100 % RDF, being at par with each other also recorded highest K content in plant (1.384 % and 1.376 %, respectively), availability in soil (133.31 and 130.10 kg/ha, respectively) and its uptake by plant (170.94 and 165.20 kg/ha, respectively). The influence of inorganic fertilization on N, P and K content of plant and in their availability in soil appeared to be due to improved nutritional environment both in the root zone and the plant system. Thus, adequate supply of N, P and K early in the crop season increased the availability of nutrients to the root zone coupled with increased metabolic activity at cellular level. It might have increased the nutrient uptake and accumulation in the vegetative plant parts. The higher nutrient content in plant also seems to be due to higher functional activity of root for longer duration under this treatment. The increase in N, P and K content in plant were also observed by Shivashankaramurthy *et al*. (2007) [12], Narayanamma *et al.* (2009) [8] and Thriveni *et al*. (2015) [14].

Organic manures

Application of vermicompost significantly influenced NPK content in plant, their availability in soil and uptake by plants. Application of vermicompost @ 8.3 t/ha (M_2) recorded maximum NPK content in plant (1.354, 1.423 and 1.386 %, respectively), available NPK in soil (85.18, 10.13 and 132.35 kg/ha, respectively) and NPK uptake by plants (162.14, 170.28 and 165.43 kg/ha, respectively).The beneficial effect of vermicompost in increasing the content of N, P and K might be attributed to direct supply of nutrients. Moreover, vermicompost after decomposition might have released macro and micro nutrients, which increases the availability of nutrients to the soil, plant system and thus increased the nutrient content in plants. The higher nutrient availability enhanced photosynthesis and their translocation to different plant parts resulting into higher concentration of nutrients. Similar findings have been reported by Nirmala *et al*. (1999) [9] and Mulani *et al.* (2007) [7].

Biofertilizers

Among Bio-fertilizers, combined application of PSB and *Azotobactor* significantly influenced N and P content in plants, their availability in soil and NPK uptake by plants. Combined use of PSB along with *Azotobactor* led maximum N and P content in plant (1.338 and 1.430 %, respectively), available N and P in soil (85.69 and 10.63 kg/ha, respectively) and NPK uptake by plants (157.25, 167.73 and 158.87 kg/ha, respectively) in comparison to sole application of PSB and *Azotobactor* and no inoculation. *Azotobactor* might have fixed higher amount of nitrogen in soil and made available to the plants resulted in better uptake of N by plants. Phosphobacteria might have led more mobilization and solubilization of insoluble P in the soil and improved the availability of phosphorus which might have caused an increase in uptake of nutrients by plants. *Azotobactor* might have fixed higher amount of nitrogen in soil and made available to the plants resulted in better uptake of N by plants. Phosphobacteria would have caused more mobilization and solubilization of insoluble P in the soil and improved the availability of phosphorus which might have caused an increase in uptake of phosphorus by plants. These finds were confirmed with results of Anjanappa *et al.* (2012) [2] in cucumber and Bindya *et al.* (2012) in Gherkin.

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