Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 4514-4521
Received: 16-03-2019
Accepted: 20-04-2019

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Studies on effect of liquid organic manures on post harvest available soil nutrients in bitter gourd

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Abstract
The experiment was aimed to determine the effect of liquid organic manures (panchagavya and vermiwash) on post harvest available soil nutrient status of bitter gourd crop. The experiment was conducted in Factorial RBD with 3 replications by foliar spraying of liquid organic manures and three varieties are used. The pooled results showed that the highest available soil nitrogen, phosphorus and potassium was recorded in the variety Peyarafuli Ucche. Whereas, among the individual number of sprays of panchagavya and vermiwash the highest available soil nitrogen, phosphorus and potassium was recorded in control i.e., water spray. In interaction effect the pooled results showed that the maximum available nitrogen, phosphorus and potash content of the soil was recorded in the treatment combination Peyarafuli Ucche and control, water spray. The highest available soil organic carbon was recorded in the treatment Gangajal-1, 3 sprays of each panchagavya 3% at 20, 40, 60 DAS and vermiwash 10% at 25, 50 and 75 DAS.

Keywords: Liquid organic manures, soil nutrient status, bitter gourd, panchagavya, vermiwash

Introduction
Bitter gourd is an important vegetable of the family cucurbitaceae. It is rich in vitamins and minerals of all the cucurbits. It is consumed as fresh vegetable after cooking; fried, dehydrated or in stuffed forms. It is used for treatment of diabetes. It has the properties to reduce the cholesterol in blood. The important cucurbitacins present in bitter gourd are momordicine and charantin for medicinal value and also which prevent the cooked vegetable from spoilage. Every day in take of bitter gourd juice has got several uses like boosting body stamina, treatment of constipation, treatment of hangover by detoxifying and nourishing liver, prevention of jaundice, chronic fatigue [1]. For sustainable production maintenance of soil health is prerequisite in intensive cultivation. The organic approach is one of the alternatives to conventional production system currently being advocated [2]. Liquid organic manures like panchagavya, vermiwash, jeevamruth and beejamruth and other various types of organic solutions prepared from plant and animal origin are effective in the promotion of growth of crops. Liquid organic manures promote immense biological activity in soil and enhance nutrient availability to crop [3]. Vermiwash is a mixture of excretory products and mucus secretion of earthworms along with micronutrients from the soil organic molecules. microbial study of vermiwash found that nitrogen fixing bacteria like *Azotobacter, Agrobacterium* and *Rhizobium* and some phosphate solublizing bacteria are also found in vermiwash [4]. But, the information on the effect of liquid organic manures on bitter gourd crop for soil available nutrient status is very meagre in terai zone of west Bengal. The present work was undertaken to determine the effect of liquid organic manures on post-harvest available nutrient status of soil in bitter gourd.

Materials and Methods
A field experiment was conducted during spring summer season (February to May) at UBKV, Pundibari, Coochbehar, West Bengal ($26^0$19'86" N latitude and $89^0$23'53" E longitude). The texture of the soil was sandy loam and pH was 5.03. The treatments of the experiment were selected for comparative study of different levels of varieties, panchagavya and vermiwash combination. The experiment was laid out in factorial randomized block design with three replications. The treatments with different levels three varieties (V_1- Peyarafuli Ucche, V_2- Pundibari Local and V_3- Gangajal-1), four panchagavya (3%) sprays (P_0– no spray (control, water spray), P_1– one spray at 45 DAS, P_2– two sprays at 30 and 60 DAS and P_3– three sprays at 20, 40 and 60 DAS) and four vermiwash (10%) sprays (W_0– no spray (control, water spray), W_1– one spray at 35 DAS, W_2– two sprays at 25 and 50 DAS and W_3– three sprays at

25, 50 and 75 DAS). The seeds were sown in 4.5 m x 1.2 m plots with the spacing of 1.5 m x 0.6 m. *Azotobacter* (5kg) enriched farmyard manure (20 t ha^{-1}) as basal along with top dressing of vermicompost (5 t ha^{-1}) at 30 days after sowing. 3% panchagavya was prepared by mixing 30 ml panchagavya in l lit of water or 300 ml panchagavya in 10 lit of water. 10% vermiwash was prepared by dissolving 100 ml of vermiwash in l lit of water or 1000 ml vermiwash in 10 lit of water. The crop was raised by following the recommended cultural practices. The composite soil samples from the entire experimental field were collected and analyzed before sowing the crop (Table 1). Soil samples were also collected after harvest of bitter gourd crop for studying the post harvest available soil nutrient status. The samples were thoroughly dried in shade, pulverized, sieved through 0.2 mm mesh and then analyzed for the determination. Two years data recorded for post harvest availability of different nutrients were statistically analysed as suggested by Panse and Sukhatme (1985) [5].

Results

Available Nitrogen Content in Soil

The data recorded on soil parameters of pooled analysis was presented. Among the varieties, the results (Table 3&3a), (Figure 1) showed that higher amount of nitrogen 110.47 kg ha^{-1} in pooled analysis in the rhizosphere soil was recorded in V_1 treatment (Peyarafuli Ucche). Among the number of sprays of panchagavya, (Figure 2) the highest available nitrogen 109.63 kg ha^{-1} in soil was recorded in P_0 treatment (control, water spray). Among the number of sprays of vermiwash, (Figure 3) the highest available nitrogen 101.56 kg ha^{-1} in the rhizosphere soil was recorded in W_0 treatment (control, water spray). Among the interaction effect of variety, panchagavya and vermiwash, (Figure 4) on available nitrogen, the highest available nitrogen 121.80 kg ha^{-1} in the rhizosphere soil was recorded in $V_1P_0W_0$ treatment (control, water spray).

Available phosphorus content in soil

Among the varieties, the results (Table 3&3a), (Figure 5) showed that higher amount of phosphorus 27.09 kg ha^{-1} in the rhizosphere soil was recorded in V_1 treatment (Peyarafuli Ucche). Among the number of sprays of panchagavya, (Figure 6) the highest available phosphorus 30.63 kg ha^{-1} in the rhizosphere soil was recorded in P_0 treatment (control, water spray). Among the number of sprays of vermiwash, (Figure 7) the highest available phosphorus 26.25 kg ha^{-1} in the rhizosphere soil was recorded in W_0 treatment (control, water spray). Among the interaction effect of variety, panchagavya and vermiwash, (Figure 8) the highest available phosphorus 35.42 kg ha^{-1} in the rhizosphere soil was recorded in $V_1P_0W_0$ treatment (Peyarafuli Ucche, control, water spray).

Available potassium content in soil

Among the varieties, the results (table 3&3a), (Figure 9) showed that higher amount of potassium 196.74 kg ha^{-1} in the rhizosphere soil was recorded inV_1 treatment (Peyarafuli Ucche). Among the number of sprays of panchagavya, (Figure 10) the highest available potassium 196.39 kg ha^{-1} in the rhizosphere soil was recorded in P_0 treatment (control, water spray). Among the number of sprays of vermiwash, (Figure 11) the highest available potassium 184.45 kg ha^{-1} in the rhizosphere soil was recorded in W_0 treatment (control, water spray). Among the interaction effect of variety, panchagavya and vermiwash, (Figure 12) the highest available potassium 216.73 kg ha^{-1} in the rhizosphere soil was recorded in $V_1P_0W_0$ (Peyarafuli Ucche, control, water spray).

Organic carbon in soil

Among the varieties, the results (Table 2&2a) showed that higher organic carbon 1.07 % in the rhizosphere soil was recorded in V_3 treatment (Gangajal-1). Among the number of sprays of panchagavya, the highest organic carbon 0.99 % in the rhizosphere soil was recorded in P_3 treatment (panchagavya 3% at 20, 40 and 60 DAS) which was statistically on par with panchagavya 3% at 45 DAS 0.97 % (P_1). Among the number of sprays of vermiwash, the highest organic carbon 1.00 % in the rhizosphere soil was recorded in W_3 treatment (vermiwash 10% at 25, 50 and 75 DAS). Among the interaction effect of variety, panchagavya and vermiwash, the highest organic carbon 1.26 % in the rhizosphere soil was recorded in $V_3P_3W_3$ treatment (Gangajal-1, panchagavya 3% at 20, 40 and 60 DAS, vermiwash 10% at 25, 50 and 75 DAS).

Discussion

The treatment control recorded highest values for available soil nitrogen, phosphorus and potassium. This might be due to more residual nitrogen in the soil and hence the yield obtained from this treatment was also very low. The treatments receiving different liquid organic manures combinely or alone along with the basal organic manures increased the organic carbon content. These basal organic manures directly adds the organic matter and these are decomposed by different microbes. Similar observation was recorded earlier by Ali *et al*. (2011) [6] in chilli-mustard, Dalal *et al*. (2014) [7] in chilli-brinjal, Ravusaheb *et al*. (2010) [8] in sesame. Poyyamoli (2006) [9] on rice found that higher amount of available macronutrients (N - 186.01 kg ha^{-1}) were observed with the application of FYM at 12.5 t ha^{-1} along with panchagavya and amuthakariasal at harvest. Similar observation was recorded earlier by Subha Mary and Lakshmi Prabha (2014) [10] in capsicum, Sundararasu and Jeyasankar (2014) [11] in brinjal. Ansari and Sukhraj (2010) [12] in okra, Ansari (2008) [13] in spinach-onion-potato. Based on the findings of the experiment it can be concluded that the foliar spray of liquid organic manures have better utilised by the bitter gourd and increased the yields so the post-harvest available soil nutrients was low in the liquid organic manure combination. The treatment (Peyarafuli Ucche, control, water spray) has recorded the highest available soil nutrient status as the yield recorded was also low in this treatment.

Conclusions

It can be concluded that the foliar applied nutrients are better utilized by the crop so the post harvest available soil nutrients are low for the liquid manures treatments. Continuous crop production through chemical fertilizers depletes the soil nutrients so to restore or improve the soil available nutrients is possible by using organic manures especially low cost liquid organic manures which are easy to prepare and apply. The study revealed that basal bulky organic manures and foliar liquid organic manures had significant effect on soil properties after harvest of bitter gourd crop.

Acknowledgements

Authors are thankful to the technical and financial support from the University, Uttar Banga Krishi Viswavidyalaya (UBKV).

Conflict of interest

No conflict of interest declared

Table 1: Physico-chemical properties of soil of experimental field before planting of crop

Particle size distribution	Value (%)		Method employed
	2016	2017	
Sand	65.11	64.87	International Pipette Method [14](Piper, 1966)
Silt	18.67	18.72	
Clay	16.22	16.41	
pH	4.65	5.03	pH meter [15](Jackson, 1967)
EC (ds m^{-1})	0.087	0.095	1:2 soil : water ratio by [15]Jackson (1967)
Organic carbon (%)	0.69	0.78	Rapid Titration Method [16](Walkley and Black, 1934)
Available nitrogen (kg ha^{-1})	112.30	116.61	Modified Macro Kjeldahl method [15](Jackson, 1967)
Available phosphorus (kg ha^{-1})	25.53	27.72	Bray's No. 1 method [15](Jackson, 1967)
Available potassium (kg ha^{-1})	179.24	183.55	Flame Photometer method [17](Jackson, 1973)

Table 2: Soil pH and organic carbon as influenced by variety, panchagavya and vermiwash and their interaction in bitter gourd

	Yield per hectare (t ha^{-1})	Organic Carbon (%)		
	Pooled	Year 1	Year 2	Pooled
Varieties (V)				
V_1	9.02	0.83	1.04	0.93
V_2	10.80	0.79	0.97	0.88
V_3	15.34	0.99	1.15	1.07
S. Em (±)	0.05	0.01	0.02	0.01
CD (P=0.05)	0.13	0.03	0.05	0.03
Panchagavya (P)				
P_0	10.12	0.89	1.04	0.97
P_1	11.11	0.88	1.05	0.97
P_2	12.01	0.81	1.02	0.92
P_3	13.66	0.91	1.08	0.99
S. Em (±)	0.05	0.01	0.02	0.01
CD (P=0.05)	0.15	0.03	NS	0.03
Vermiwash (W)				
W_0	11.25	0.86	1.01	0.94
W_1	11.81	0.87	1.05	0.96
W_2	11.73	0.86	1.05	0.95
W_3	12.11	0.90	1.09	1.00
S. Em (±)	0.05	0.01	0.02	0.01
CD (P=0.05)	0.15	0.03	NS	0.03
V X P X W				
$V_1P_0W_0$	6.08	0.84	0.86	0.85
$V_1P_0W_1$	6.30	0.81	0.97	0.89
$V_1P_0W_2$	6.47	0.84	1.12	0.98
$V_1P_0W_3$	6.59	1.06	1.18	1.12
$V_1P_1W_0$	7.85	0.78	0.85	0.81
$V_1P_1W_1$	8.27	0.75	0.99	0.87
$V_1P_1W_2$	8.90	0.87	1.07	0.97
$V_1P_1W_3$	9.17	1.03	1.11	1.07
$V_1P_2W_0$	8.92	0.88	1.29	1.09
$V_1P_2W_1$	9.62	0.87	1.11	0.99
$V_1P_2W_2$	10.59	0.73	1.04	0.89
$V_1P_2W_3$	11.45	0.67	0.96	0.82
$V_1P_3W_0$	10.93	0.70	0.97	0.83
$V_1P_3W_1$	11.12	0.92	1.13	1.02
$V_1P_3W_2$	11.20	0.82	1.10	0.96
$V_1P_3W_3$	11.04	0.73	0.85	0.80
$V_2P_0W_0$	11.35	0.72	0.84	0.78
$V_2P_0W_1$	11.58	0.80	0.88	0.84
$V_2P_0W_2$	9.94	0.77	0.90	0.84
$V_2P_0W_3$	10.45	0.68	0.99	0.83

*Treatment details are in materials and methods

Table 2a: Interaction effect of variety, panchagavya and vermiwash on soil pH and organic carbon in bitter gourd

	Yield per hectare (t ha^{-1})	Organic Carbon (%)		
	Pooled	Year 1	Year 2	Pooled
$V_2P_1W_0$	10.58	0.93	1.03	0.98
$V_2P_1W_1$	10.65	0.74	0.99	0.87
$V_2P_1W_2$	9.40	0.98	1.10	1.04
$V_2P_1W_3$	9.74	0.79	1.07	0.93
$V_2P_2W_0$	10.79	0.81	1.01	0.91

$V_2P_2W_1$	12.02	1.01	1.16	1.08
$V_2P_2W_2$	9.77	0.56	0.79	0.68
$V_2P_2W_3$	10.46	0.72	0.86	0.79
$V_2P_3W_0$	11.81	0.74	0.84	0.79
$V_2P_3W_1$	12.13	0.78	0.90	0.84
$V_2P_3W_2$	10.88	0.84	1.04	0.94
$V_2P_3W_3$	11.27	0.86	1.06	0.97
$V_3P_0W_0$	11.24	1.05	1.19	1.13
$V_3P_0W_1$	12.32	1.10	1.26	1.18
$V_3P_0W_2$	14.43	1.07	1.18	1.12
$V_3P_0W_3$	14.74	0.98	1.16	1.07
$V_3P_1W_0$	14.18	0.90	1.03	0.97
$V_3P_1W_1$	14.40	0.83	1.01	0.92
$V_3P_1W_2$	14.87	1.01	1.16	1.09
$V_3P_1W_3$	15.35	1.00	1.18	1.09
$V_3P_2W_0$	14.40	0.83	1.01	0.92
$V_3P_2W_1$	15.05	0.76	0.92	0.84
$V_3P_2W_2$	15.40	0.72	0.84	0.78
$V_3P_2W_3$	15.65	1.13	1.31	1.22
$V_3P_3W_0$	16.93	1.12	1.28	1.20
$V_3P_3W_1$	18.33	1.11	1.26	1.18
$V_3P_3W_2$	18.93	1.08	1.26	1.17
$V_3P_3W_3$	19.37	1.19	1.32	1.26
S. Em (±)	0.19	0.04	0.08	0.04
CD (P=0.05)	0.52	0.12	0.21	0.12

*Treatment details are in material and methods

Table 3: Available soil N, P and K as influenced by variety, panchagavya and vermiwash and their interaction in bitter gourd

	Available Nitrogen (kg/ha)			**Available Phosphorus (kg/ha)**			**Available Potassium (kg/ha)**		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Varieties (V)									
V_1	107.76	113.17	110.47	26.24	27.94	27.09	194.89	198.60	196.74
V_2	90.83	97.42	94.12	25.27	26.84	26.06	170.11	177.78	173.95
V_3	93.41	99.26	96.33	20.98	21.86	21.42	170.10	175.20	172.65
S. Em (±)	0.18	0.19	0.13	0.06	0.17	0.09	0.75	0.78	0.54
CD (P=0.05)	0.50	0.53	0.36	0.16	0.47	0.24	2.10	2.20	1.51
Panchagavya (P)									
P_0	106.90	112.37	109.63	29.28	31.97	30.63	193.54	199.25	196.39
P_1	96.87	102.98	99.93	25.93	27.16	26.55	180.77	183.30	182.04
P_2	93.36	99.51	96.44	21.99	22.84	22.42	168.62	179.00	173.81
P_3	92.22	98.29	95.26	19.47	20.24	19.86	170.55	173.93	172.24
S. Em (±)	0.21	0.22	0.15	0.07	0.19	0.10	0.86	0.90	0.63
CD (P=0.05)	0.58	0.61	0.42	0.19	0.54	0.28	2.42	2.54	1.74
Vermiwash (W)									
W_0	98.53	104.60	101.56	25.46	27.03	26.25	182.41	186.48	184.45
W_1	97.76	103.83	100.79	25.04	26.48	25.76	179.18	184.56	181.87
W_2	97.11	102.89	100.00	23.22	24.59	23.91	177.53	182.95	180.24
W_3	95.96	101.84	98.90	22.96	24.11	23.53	174.35	181.47	177.91
S. Em (±)	0.21	0.22	0.15	0.07	0.19	0.10	0.86	0.90	0.63
CD (P=0.05)	0.58	0.61	0.42	0.19	0.54	0.28	2.42	2.54	1.74
V X P X W									
$V_1P_0W_0$	119.08	124.51	121.80	32.77	38.07	35.42	215.06	218.40	216.73
$V_1P_0W_1$	118.06	123.49	120.78	31.49	35.62	33.56	209.68	215.62	212.65
$V_1P_0W_2$	117.27	122.82	120.05	30.92	34.56	32.74	207.35	212.79	210.07
$V_1P_0W_3$	116.98	121.07	119.03	30.81	33.53	32.17	207.59	212.36	209.98
$V_1P_1W_0$	102.86	110.18	106.52	29.24	30.59	29.92	188.05	195.53	191.79
$V_1P_1W_1$	102.12	109.92	106.02	29.04	30.13	29.59	186.53	193.65	190.09
$V_1P_1W_2$	101.80	106.95	104.38	28.95	30.00	29.48	190.38	192.67	191.53
$V_1P_1W_3$	99.71	105.38	102.55	28.75	29.82	29.29	188.58	192.58	190.58
$V_1P_2W_0$	98.85	104.28	101.57	28.53	29.32	28.93	180.99	181.61	181.30
$V_1P_2W_1$	98.19	103.50	100.85	28.09	29.14	28.62	187.46	183.44	185.45
$V_1P_2W_2$	111.46	115.31	113.39	20.71	21.90	21.31	195.89	198.37	197.13
$V_1P_2W_3$	109.76	114.73	112.25	20.56	21.45	21.01	194.33	197.42	195.88
$V_1P_3W_0$	108.57	114.13	111.35	20.37	21.29	20.83	193.43	196.18	194.81
$V_1P_3W_1$	108.05	112.12	110.09	20.09	20.91	20.50	193.39	196.81	195.10
$V_1P_3W_2$	106.42	111.76	109.09	19.87	20.60	20.24	191.66	195.99	193.83
$V_1P_3W_3$	105.14	110.63	107.89	19.76	20.24	20.00	187.94	194.20	191.07
$V_2P_0W_0$	89.61	96.41	93.01	30.20	33.17	31.69	177.94	190.89	184.42

$V_2P_0W_1$	88.68	95.35	92.02	30.14	32.75	31.45	170.73	169.13	169.93
$V_2P_0W_2$	87.88	94.13	91.01	29.76	32.63	31.20	162.02	169.62	165.82
$V_2P_0W_3$	86.56	93.84	90.20	29.61	32.01	30.81	161.15	168.71	164.93

*Treatment details are in materials and methods

Table 3a: Interaction effect of variety, panchagavya and vermiwash on available N, P and K in bitter gourd

	Available Nitrogen (kg/ha)			Available Phosphorus (kg/ha)			Available Potassium (kg/ha)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
$V_2P_1W_0$	85.26	92.38	88.82	29.56	31.12	30.34	162.28	165.94	164.11
$V_2P_1W_1$	84.31	91.88	88.10	29.27	30.71	29.99	166.60	165.59	166.10
$V_2P_1W_2$	97.79	102.38	100.09	23.95	25.43	24.69	189.95	185.56	187.76
$V_2P_1W_3$	96.84	101.42	99.13	23.86	25.11	24.49	180.42	182.01	181.22
$V_2P_2W_0$	94.70	100.56	97.63	23.81	24.66	24.24	178.81	179.68	179.25
$V_2P_2W_1$	93.74	100.47	97.11	23.28	24.16	23.72	159.40	189.72	174.56
$V_2P_2W_2$	93.33	100.09	96.71	22.65	23.68	23.17	152.85	183.26	168.05
$V_2P_2W_3$	92.39	99.33	95.86	22.35	23.25	22.80	153.32	189.20	171.26
$V_2P_3W_0$	91.25	98.76	95.01	22.01	23.09	22.55	179.13	174.51	176.82
$V_2P_3W_1$	90.40	98.12	94.26	21.59	22.88	22.24	176.34	172.12	174.23
$V_2P_3W_2$	90.33	96.99	93.66	21.37	22.63	22.00	179.46	181.98	180.72
$V_2P_3W_3$	90.27	96.68	93.48	21.02	22.26	21.64	171.45	176.71	174.08
$V_3P_0W_0$	115.75	120.38	118.07	27.10	28.51	27.81	206.49	216.52	211.51
$V_3P_0W_1$	115.00	119.59	117.30	27.07	28.05	27.56	202.37	210.66	206.52
$V_3P_0W_2$	114.25	118.80	116.53	26.21	27.66	26.94	202.10	203.67	202.89
$V_3P_0W_3$	113.65	118.03	115.84	25.33	27.08	26.21	199.95	202.56	201.26
$V_3P_1W_0$	112.96	117.13	115.05	25.22	26.95	26.09	198.71	200.49	199.60
$V_3P_1W_1$	111.95	115.90	113.93	24.54	26.31	25.43	197.02	199.93	198.48
$V_3P_1W_2$	83.85	91.57	87.71	19.54	19.92	19.73	162.28	164.49	163.39
$V_3P_1W_3$	83.02	90.68	86.85	19.27	19.86	19.57	158.46	161.13	159.80
$V_3P_2W_0$	82.76	90.10	86.43	18.79	19.52	19.16	154.68	161.18	157.93
$V_3P_2W_1$	82.35	89.52	85.94	18.51	19.44	18.98	147.75	161.90	154.83
$V_3P_2W_2$	81.55	88.58	85.07	18.48	19.11	18.80	160.53	161.97	161.25
$V_3P_2W_3$	81.31	87.63	84.47	18.12	18.45	18.29	157.45	160.22	158.84
$V_3P_3W_0$	80.72	86.34	83.53	17.93	18.10	18.02	153.41	156.82	155.12
$V_3P_3W_1$	80.29	86.05	83.17	17.35	17.60	17.48	152.90	156.19	154.55
$V_3P_3W_2$	79.35	85.33	82.34	16.28	17.00	16.64	135.93	145.04	140.49
$V_3P_3W_3$	75.84	82.61	79.23	16.04	16.23	16.14	131.58	140.56	136.07
S. Em (±)	0.72	0.75	0.52	0.23	0.66	0.35	2.99	3.13	2.17
CD (P=0.05)	2.01	2.11	1.45	0.65	1.86	0.98	8.39	8.80	6.04

*Treatment details are in materials and methods

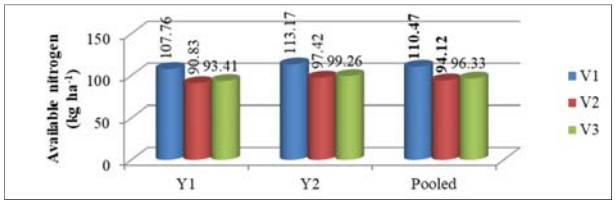

Fig 1: Individual effect of varieties on available nitrogen (kg ha^{-1})

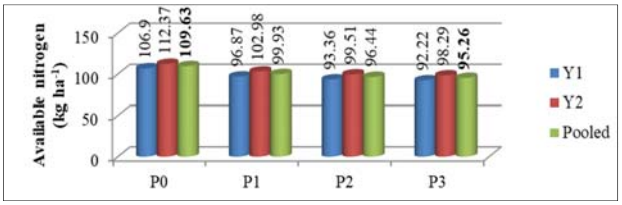

Fig 2: Individual effect of panchagavya on available nitrogen (kg ha^{-1})

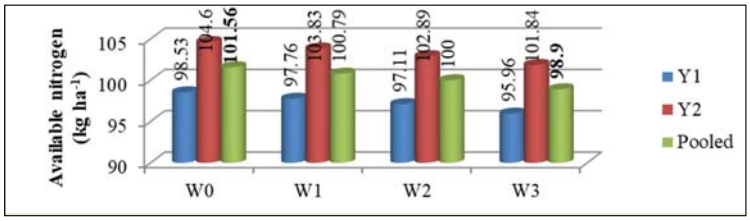

Fig 3: Individual effect of vermiwash on available nitrogen (kg ha^{-1})

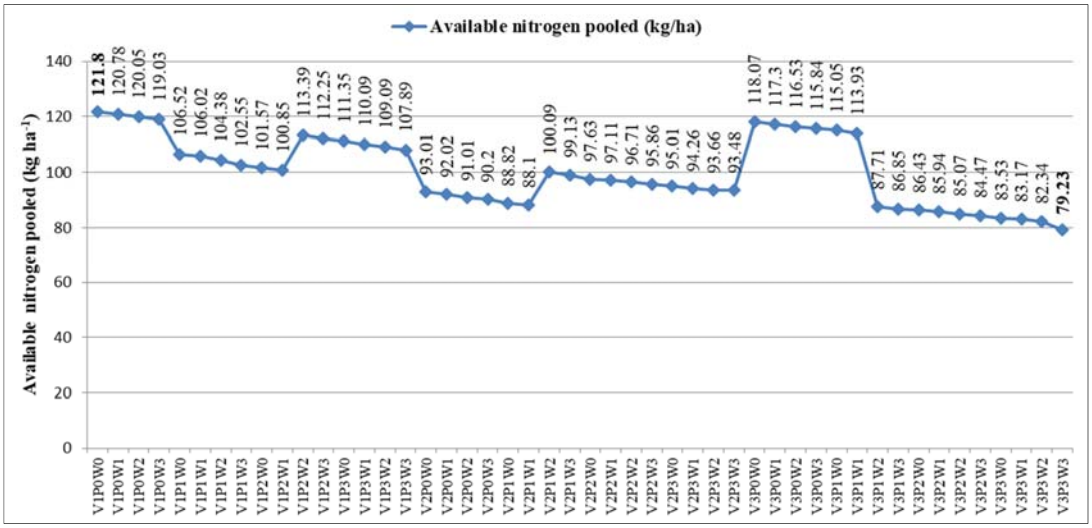

Fig 4: Interaction effect of varieties, panchagavya and vermiwash on available nitrogen (kg ha^{-1})

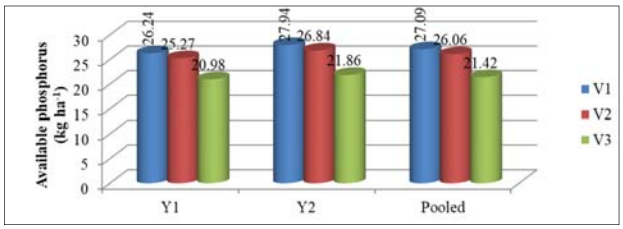

Fig 5: Individual effect of varieties on available phosphorus (kg ha^{-1})

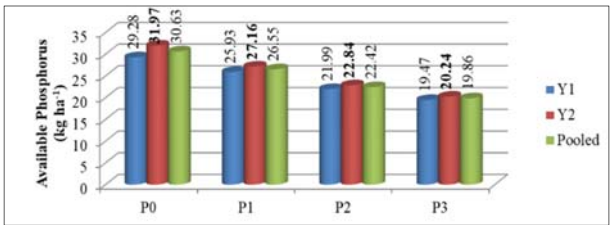

Fig 6: Individual effect of panchagavya on available phosphorus (kg ha^{-1})

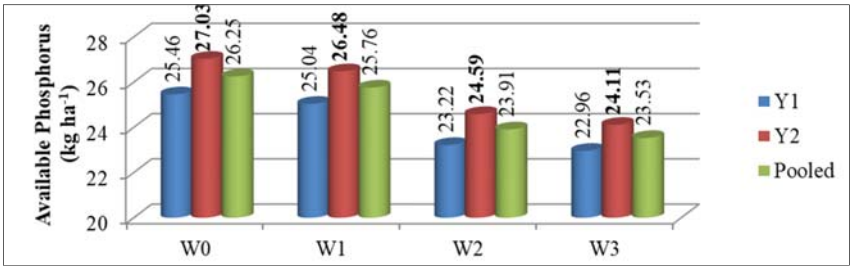

Fig 7: Individual effect of vermiwash on available phosphorus (kg ha^{-1})

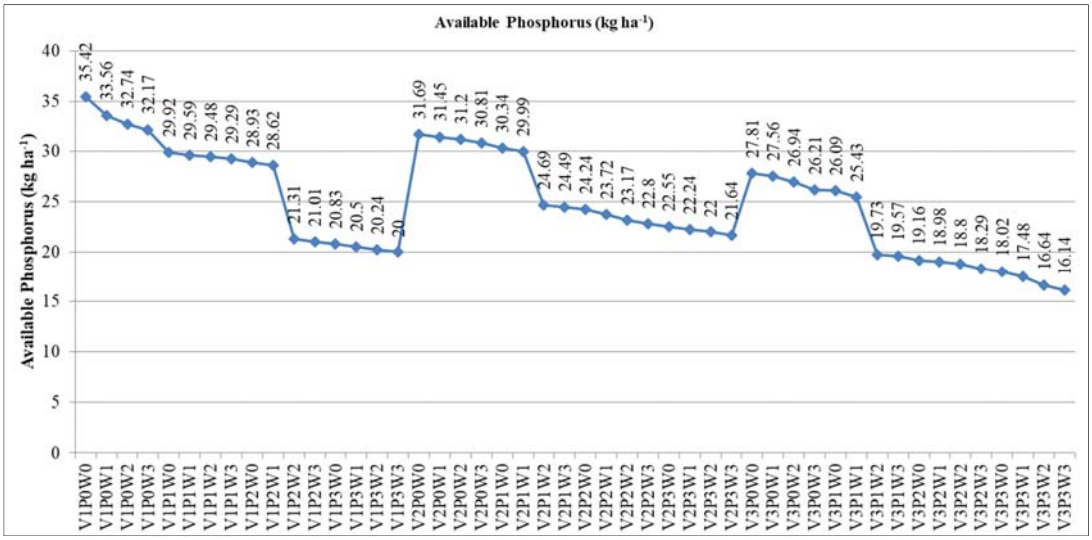

Fig 8: Interaction effect of varieties and panchagavya on available phosphorus (kg ha^{-1})

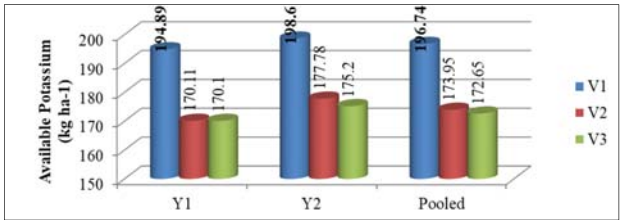

Fig 9: Individual effect of varieties on available potassium (kg ha^{-1})

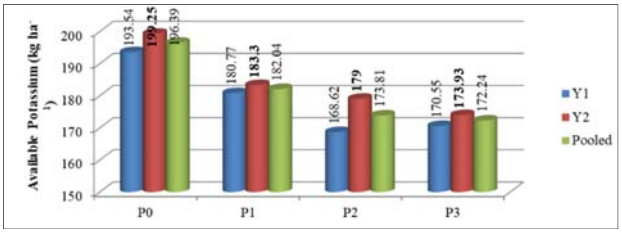

Fig 10: Individual effect of panchagavya on available potassium (kg ha^{-1})

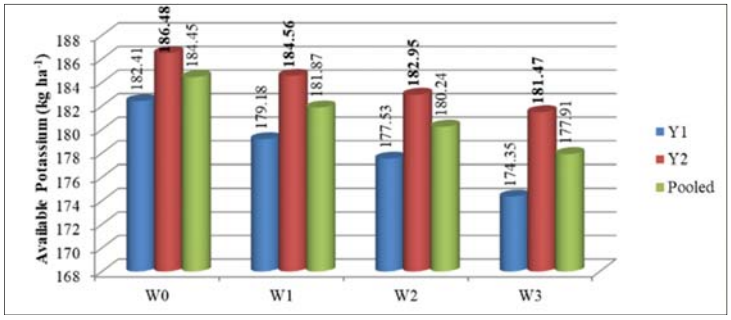

Fig 11: Individual effect of vermiwash on available potassium (kg ha^{-1})

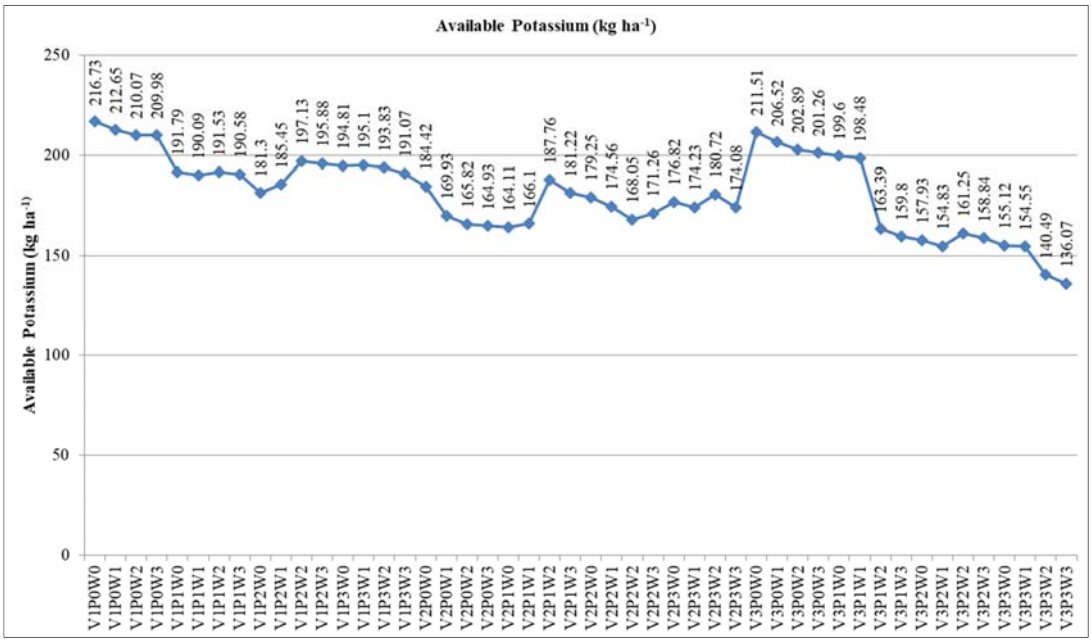

Fig 12: Interaction effect of varieties and panchagavya on available potassium (kg ha^{-1})

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