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## Effect of foliar application of Panchagavya and Vermiwash on yield and quality of bitter gourd (*Momordica charantia* L.)

**Somashekar Gajjela and Ranjit Chatterjee**

### Abstract

The objective of the study was to determine the effect of foliar application of Panchagavya and Vermiwash on yield and quality of bitter gourd (*Momordica charantia* L.). For this, three different varieties (V) of bitter gourd, Panchagavya (P) 3% i.e., 30 ml/lit (4 levels) and Vermiwash (W) 10% i.e., 100 ml/lit(4 levels) were used in bitter gourd. The results indicated that foliar application of Panchagavya; Vermiwash; and their interaction recorded highest fruit length (12.79 cm; 11.13 cm and 17.74 cm), number of fruits per plant (21.86; 21.38 and 25.50), single fruit weight (62.31 g; 57.59 g and 75.93 g), yield per plant (1.37 kg; 1.21 kg and 1.94 kg), yield per plot (8.20 kg/5.4m<sup>2</sup>; 7.26 kg/5.4m<sup>2</sup> and 11.62 kg/5.4m<sup>2</sup>), yield per hectare (13.66 t/ha; 12.11 t/ha and 19.37 t/ha), total soluble solids (1.70°Brix; 1.48°Brix and 0.97°Brix), ascorbic acid (82.80 mg/100g; 75.26 mg/100g and 55.73 mg/100g), protein (1.52 %; 1.45 % and 1.06 %) in pooled analysis compared to control. The study confirmed that foliar application of Panchagavya, Vermiwash has the potential effect in bitter gourd.

**Keywords:** Foliar application, Panchagavya, Vermiwash, bitter gourd, yield

### Introduction

Bitter gourd (*Momordica charantia* L.) is an important fruit vegetable of the family Cucurbitaceae. It is a monoecious, viny, annual climber, cultivated in tropical and sub-tropical areas during summer and rainy season. In areas, where climate is mild it can be grown throughout the year. The somatic chromosome number of *Momordica charantia* is  $2n = 2x = 22$ . It is cultivated in an area of 83.22 MHA with an annual production of 940.15 MT in India NHB, [7]. Bitter gourd contains considerable amount of water (83-92%), carbohydrates (4.0-10.5%), protein (1.5-2.0%), fat (0.2-1.0%), minerals (0.5-1.0%) and fiber (0.8-1.7 %) Gopalan [2]. Ripe fruits are rich in vitamin-A. Bitter gourd contains maximum amount of minerals and vitamins among all cucurbits. It is also exported due to its high keeping quality Banerjee and Mangal, [1]. Bitter gourd has been used as a folk remedy for tumors, asthma, skin infections, gastro intestinal problems, and hypertension. It has the benefit of reducing the diabetes mellitus by lowering the sugar levels in blood because of presence of three different groups of constituents. They are steroidal saponins known as charantin, insulin like peptides, and alkaloids. 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 Sampath, [8].

In recent days, liquid organic manures are getting relevance in organic cultivation. Panchagavya is a fermented liquid made by blending five ingredients obtained from cow, such as milk, urine, dung, curd and clarified butter. It has been using in Indian medicine since time immemorial in allelopathy, with deep conviction in ecological farming, sustainable agriculture, traditional knowledge and utilized to cultivate medicinal herbs. Panchagavya sprayed plants produce larger leaves and denser canopy. More lateral shoots are produced on stem which are sturdy to bear heavier yields. Profuse rooting which penetrate deeper layers for better uptake of nutrients and water. Plants are also able to withstand prolonged drought conditions and needs a less number of irrigations Sivakumar, [10]. Vermiwash is another liquid organic manure that is collected after the passage of water through a column of worm action. It is a mixture of excretory products and mucus secretion of earthworms along with micronutrients from the soil organic molecules. It contains nitrogen as nitrogenous excretory product and growth promoting hormones and essential enzymes and infuses resistance in plants. It contains various enzymes mixture of protease, amylase, urease and phosphatase. These are beneficial for growth and development of plant and stimulate the yield and productivity of crops and also microbial study of vermiwash found that nitrogen fixing bacteria like *Azotobacter*, *Agrobacterium* and *Rhizobium* and some phosphate solubilizing bacteria are also found in vermiwash Kaur [3].

Today's production involves utilization of chemical fertilizers, pesticides and growth regulators for enhancing crop production. But, over dependence on chemical fertilizers adversely affects the soil and environment and also on humans. For sustainable production maintenance of soil health is prerequisite in

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intensive cultivation. The organic approach is one of the alternatives to conventional production system currently being advocated Subbarao [11]. The present day organic bitter gourd cultivation depends on bulky organic manure like farmyard manure, vermicompost and in some cases poultry manure. As these manures contain very low amount of plant nutrients and their mineralization rate is also very low. Therefore farmers are not getting desired yield from organic bitter gourd cultivation. Several research works suggested that application of liquid organic manures in addition to normal bulky organic manure may enhance the fruit yield besides better quality and storability. Further, the information on performance of organic bitter gourd in combination with liquid organic manures is meager in terai zone of West Bengal. Keeping the above facts in view the present study was undertaken.

### Materials and Methods

The experiment was conducted at UBKV, Pundibari, Cooch Behar, West Bengal, India. (26°19'86" N latitude and 89°23'53" E longitude) during 2016 and 2017. Bitter gourd was raised during spring summer season (February to May) in both the years. The seeds of three varieties were purchased from the local seed market. Panchagavya was prepared by using 5 kg of cow dung and 1 kg of ghee, 3 lit of cow urine, 10 lit of water, 2 lit of cow milk and 2 lit of curd. 3% panchagavya was prepared by mixing 30 ml panchagavya in 1 lit of water or 300 ml panchagavya in 10 lit of water. Vermiwash was collected from vermicompost pits of ELP Unit, Department of Agronomy, Faculty of Agriculture, UBKV, West Bengal. 10% vermiwash was prepared by dissolving 100 ml of vermiwash in 1 lit of water or 1000 ml vermiwash in 10 lit of water. The experiment was laid out in three factor factorial randomized block design with 48 treatment combinations and replicated thrice. The seeds were sown in 4.5 m x 1.2 m plots with the spacing of 1.5 m x 0.6 m. This experiment consists of three factors viz., three varieties (V<sub>1</sub>- Peyarafuli Ucche, V<sub>2</sub>- Pundibari Local and V<sub>3</sub>- Gangajal-1), four panchagavya(3%) sprays (P<sub>0</sub>- no spray (control, water spray), P<sub>1</sub>- one spray at 45 DAS, P<sub>2</sub>- two sprays at 30 and 60 DAS and P<sub>3</sub>- three sprays at 20, 40 and 60 DAS) and four vermiwash(10%) sprays (W<sub>0</sub>- no spray (control, water spray), W<sub>1</sub>- one spray at 35 DAS, W<sub>2</sub>- two sprays at 25 and 50 DAS and W<sub>3</sub>- three sprays at 25, 50 and 75 DAS).

Three randomly chosen plants in each treatment were labelled and used for recording the observations. The mean of three plants was calculated and used for analysis. The observations were recorded on yield characters like fruit length (cm), number of fruits per plant, single fruit weight (g), yield per plant (kg), yield per plot (kg/5.4m<sup>2</sup>), yield per hectare (t/ha), quality parameters like total soluble solids (°Brix) Mettler Toledo RE50 refractometer was used, ascorbic acid (mg/100g) was determined by titrimetric method and protein (%) content of the bitter gourd sample was estimated by multiplying the total nitrogen by coefficient 6.25.

## Results and Discussion

### Effect of panchagavya on yield and quality

The increase in fruit length (39.78%), number of fruits per plant (9.35%), single fruit weight (23.19%), yield of fruit per plant (35.64%), plot yield (35.09%), yield of fruit (34.98%), total soluble solids(33.86%), ascorbic acid(38.74%) and protein content(14.29%) in bitter gourd was recorded in P<sub>3</sub> treatment (panchagavya 3% at 20, 40 and 60 DAS) in pooled analysis. Increase in fruit weight by spray of liquid organic manures may be due to translocation of more amount of carbohydrates to developing fruits and utilization of nutrients from basal applied farm yard manure and vermicompost. Similar observation was recorded earlier by Sangeetha [9] in bitter gourd.

### Effect of vermiwash on yield and quality

The increase in fruit length (10.64), number of fruits per plant (1.45%), single fruit weight (5.36%), yield of fruit per plant (7.08%), plot yield (7.56%), yield of fruit (7.64%), total soluble solids(10.45%), ascorbic acid(8.71%) and protein content (3.57%) in bitter gourd was recorded in W<sub>3</sub> treatment (vermiwash 10% at 25, 50 and 75 DAS) in pooled analysis. As the vermiwash is a coelomic fluid extraction which contains plant growth substances which might have stimulated for increase in yield per plot of bitter gourd. Kumawat [4] obtained 58% and 72% increase in grain and straw yield of cumin respectively, with application of neem + panchagavya. Total soluble solids might have increased due to better role of nutrients which is involved in the carbohydrate synthesis, breakdown and translocation of starch, synthesis of protein and neutralization of physiologically important organic acids. Foliar application of nutrient through humic sources increases the uptake and availability of nutrient and its further assimilation for biosynthesis of protein.

### Interaction effect of variety, panchagavya and vermiwash on yield and quality

The highest fruit length (36.46%), number of fruits per plant (47.06%), single fruit weight (17.19%), yield of fruit per plant (71.68%), plot yield (72.40%), yield of fruit (72.33%), total soluble solids (19.65%), ascorbic acid (60.93%) and protein content (23.18%) in bitter gourd was recorded in V<sub>3</sub>P<sub>3</sub>W<sub>3</sub> treatment (Gangajal-1, panchagavya 3% at 20, 40 and 60 DAS, vermiwash 10% at 25, 50 and 75 DAS) in pooled analysis. Foliar spray of panchagavya @ 3% resulted in a significant increase in the yield attributes this may be due to the panchagavya contains coconut water, which contains kinetin which increases the biomass and yield. By foliar spray of panchagavya all the yield and quality parameters are improved. This might be due to the faster absorption of nutrients like urea present in panchagavya through cuticle of leaves. Similar observation was recorded earlier by Meerabai [5], Muhammad [6] in bitter gourd.

**Table 1:** Yield parameters as influenced by variety, panchagavya and vermiwash and their interaction in bitter gourd

	Fruit length (cm)			Number of fruits per plant			Single fruit weight (g)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
<b>Varieties (V)</b>									
V <sub>1</sub>	5.71	6.33	6.02	22.03	23.18	22.60	39.20	40.09	39.65
V <sub>2</sub>	12.16	13.11	12.64	17.76	19.17	18.47	58.08	59.17	58.62
V <sub>3</sub>	12.66	13.61	13.14	20.97	22.81	21.89	69.36	70.24	69.80
S. Em (±)	0.05	0.06	0.04	0.08	0.12	0.07	0.32	0.48	0.29
CD (P=0.05)	0.15	0.16	0.11	0.22	0.34	0.20	0.89	1.36	0.81
<b>Panchagavya (P)</b>									

P <sub>0</sub>	8.76	9.54	9.15	19.17	20.80	19.99	50.06	51.10	50.58
P <sub>1</sub>	9.29	10.08	9.69	20.57	21.74	21.16	52.74	53.79	53.27
P <sub>2</sub>	10.29	11.27	10.78	20.21	21.72	20.96	57.44	58.47	57.95
P <sub>3</sub>	12.38	13.20	12.79	21.08	22.63	21.86	61.96	62.65	62.31
S. Em (±)	0.06	0.07	0.05	0.09	0.14	0.08	0.37	0.56	0.33
CD (P=0.05)	0.17	0.19	0.13	0.25	0.40	0.23	1.03	1.56	0.93
<b>Vermiwash (W)</b>									
W <sub>0</sub>	9.65	10.47	10.06	19.99	21.47	20.73	54.21	55.11	54.66
W <sub>1</sub>	10.06	10.93	10.49	20.60	22.16	21.38	54.96	55.89	55.43
W <sub>2</sub>	10.29	11.16	10.72	20.10	21.55	20.83	55.94	56.94	56.44
W <sub>3</sub>	10.72	11.54	11.13	20.35	21.72	21.03	57.09	58.08	57.59
S. Em (±)	0.06	0.07	0.05	0.09	0.14	0.08	0.37	0.56	0.33
CD (P=0.05)	0.17	0.19	0.13	0.25	0.40	0.23	1.03	1.56	0.93
<b>V X P X W</b>									
V <sub>1</sub> P <sub>0</sub> W <sub>0</sub>	4.02	4.30	4.16	19.13	20.27	19.70	30.69	31.00	30.85
V <sub>1</sub> P <sub>0</sub> W <sub>1</sub>	4.59	4.67	4.63	19.47	20.60	20.04	30.97	31.85	31.41
V <sub>1</sub> P <sub>0</sub> W <sub>2</sub>	4.84	5.10	4.97	19.47	20.60	20.04	31.25	33.23	32.25
V <sub>1</sub> P <sub>0</sub> W <sub>3</sub>	4.99	5.37	5.18	19.47	20.60	20.04	32.03	33.71	32.87
V <sub>1</sub> P <sub>1</sub> W <sub>0</sub>	6.12	7.08	6.60	23.00	24.27	23.64	32.57	33.79	33.18
V <sub>1</sub> P <sub>1</sub> W <sub>1</sub>	6.20	7.40	6.80	23.33	24.27	23.80	34.59	34.85	34.72
V <sub>1</sub> P <sub>1</sub> W <sub>2</sub>	6.29	7.70	6.99	23.33	24.60	23.97	36.34	37.91	37.13
V <sub>1</sub> P <sub>1</sub> W <sub>3</sub>	6.44	7.39	6.92	23.33	24.60	23.97	38.21	38.31	38.26
V <sub>1</sub> P <sub>2</sub> W <sub>0</sub>	6.56	7.53	7.05	21.67	23.60	22.64	39.13	39.66	39.40
V <sub>1</sub> P <sub>2</sub> W <sub>1</sub>	6.71	8.06	7.39	23.33	23.60	23.47	39.89	42.03	40.96
V <sub>1</sub> P <sub>2</sub> W <sub>2</sub>	5.22	5.52	5.37	24.00	24.60	24.30	43.51	43.64	43.58
V <sub>1</sub> P <sub>2</sub> W <sub>3</sub>	5.37	5.9	5.58	24.00	24.60	24.30	46.42	47.78	47.10
V <sub>1</sub> P <sub>3</sub> W <sub>0</sub>	5.40	6.08	5.74	22.33	23.60	22.97	46.96	48.13	47.55
V <sub>1</sub> P <sub>3</sub> W <sub>1</sub>	5.75	6.29	6.02	22.00	24.27	23.14	47.81	48.30	48.05
V <sub>1</sub> P <sub>3</sub> W <sub>2</sub>	5.86	6.44	6.15	22.33	23.93	23.13	48.28	48.52	48.40
V <sub>1</sub> P <sub>3</sub> W <sub>3</sub>	7.02	6.65	6.84	22.33	22.93	22.63	48.71	48.85	48.78
V <sub>2</sub> P <sub>0</sub> W <sub>0</sub>	7.87	8.41	8.14	20.80	21.47	21.14	53.24	54.18	53.71
V <sub>2</sub> P <sub>0</sub> W <sub>1</sub>	8.55	9.75	9.15	21.13	21.80	21.47	53.59	54.29	53.94
V <sub>2</sub> P <sub>0</sub> W <sub>2</sub>	9.05	10.12	9.59	16.67	19.80	18.24	53.92	54.97	54.45
V <sub>2</sub> P <sub>0</sub> W <sub>3</sub>	9.41	10.31	9.86	18.33	19.80	19.07	54.20	55.32	54.76

\*Treatment details are in materials and methods

**Table 2:** Interaction effect of variety, panchagavya and vermiwash on yield parameters in bitter gourd

	Fruit length (cm)			Number of fruits per plant			Single fruit weight (g)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
V <sub>2</sub> P <sub>1</sub> W <sub>0</sub>	10.56	10.98	10.77	18.67	19.80	19.24	54.29	55.69	54.99
V <sub>2</sub> P <sub>1</sub> W <sub>1</sub>	11.15	11.89	11.52	18.67	19.47	19.07	55.13	56.50	55.82
V <sub>2</sub> P <sub>1</sub> W <sub>2</sub>	11.71	12.35	12.03	16.33	17.13	16.73	55.45	56.86	56.16
V <sub>2</sub> P <sub>1</sub> W <sub>3</sub>	11.89	12.62	12.26	16.67	17.47	17.07	56.37	57.72	57.05
V <sub>2</sub> P <sub>2</sub> W <sub>0</sub>	12.34	13.75	13.05	18.00	19.13	18.57	57.66	58.52	58.09
V <sub>2</sub> P <sub>2</sub> W <sub>1</sub>	12.76	13.83	13.30	19.00	21.80	20.40	58.40	59.38	58.89
V <sub>2</sub> P <sub>2</sub> W <sub>2</sub>	14.27	14.78	14.53	15.67	16.47	16.07	60.09	61.47	60.78
V <sub>2</sub> P <sub>2</sub> W <sub>3</sub>	14.39	15.28	14.84	16.33	17.13	16.73	61.74	63.18	62.46
V <sub>2</sub> P <sub>3</sub> W <sub>0</sub>	14.60	15.81	15.20	18.33	19.13	18.73	62.58	63.43	63.01
V <sub>2</sub> P <sub>3</sub> W <sub>1</sub>	15.11	16.30	15.71	18.33	19.80	19.07	63.24	63.97	63.61
V <sub>2</sub> P <sub>3</sub> W <sub>2</sub>	15.45	16.77	16.11	15.67	18.13	16.90	63.76	64.83	64.30
V <sub>2</sub> P <sub>3</sub> W <sub>3</sub>	15.53	16.90	16.22	15.67	18.47	17.07	65.62	66.41	66.02
V <sub>3</sub> P <sub>0</sub> W <sub>0</sub>	12.35	13.64	13.00	16.00	18.67	17.34	64.29	65.29	64.79
V <sub>3</sub> P <sub>0</sub> W <sub>1</sub>	12.74	13.89	13.32	16.67	21.00	18.84	64.81	65.81	65.31
V <sub>3</sub> P <sub>0</sub> W <sub>2</sub>	13.19	14.24	13.72	21.47	22.33	21.90	65.50	66.20	65.85
V <sub>3</sub> P <sub>0</sub> W <sub>3</sub>	13.57	14.66	14.12	21.47	22.67	22.07	66.26	67.34	66.80
V <sub>3</sub> P <sub>1</sub> W <sub>0</sub>	9.72	10.06	9.89	20.13	22.00	21.07	66.82	67.71	67.27
V <sub>3</sub> P <sub>1</sub> W <sub>1</sub>	10.27	10.47	10.37	20.47	22.00	21.24	67.33	68.24	67.79
V <sub>3</sub> P <sub>1</sub> W <sub>2</sub>	10.36	11.38	10.87	21.47	22.33	21.90	67.35	68.36	67.86
V <sub>3</sub> P <sub>1</sub> W <sub>3</sub>	10.77	11.67	11.22	21.47	23.00	22.24	68.50	69.58	69.04
V <sub>3</sub> P <sub>2</sub> W <sub>0</sub>	11.12	12.04	11.58	19.13	22.00	20.57	69.53	70.46	70.00
V <sub>3</sub> P <sub>2</sub> W <sub>1</sub>	11.24	12.32	11.78	20.47	22.00	21.24	70.45	71.23	70.84
V <sub>3</sub> P <sub>2</sub> W <sub>2</sub>	11.47	12.82	12.15	20.47	22.67	21.57	70.95	71.80	71.38
V <sub>3</sub> P <sub>2</sub> W <sub>3</sub>	12.02	13.56	12.79	20.47	23.00	21.74	71.47	72.47	71.97
V <sub>3</sub> P <sub>3</sub> W <sub>0</sub>	15.17	15.98	15.58	22.67	23.67	23.17	72.74	73.39	73.07
V <sub>3</sub> P <sub>3</sub> W <sub>1</sub>	15.63	16.26	15.95	24.33	25.33	24.83	73.33	74.28	73.81
V <sub>3</sub> P <sub>3</sub> W <sub>2</sub>	15.80	16.67	16.24	24.33	26.00	25.17	74.88	75.49	75.19
V <sub>3</sub> P <sub>3</sub> W <sub>3</sub>	17.21	18.25	17.74	24.67	26.33	25.50	75.61	76.25	75.93
S. Em (±)	0.21	0.23	0.16	0.31	0.49	0.29	1.27	1.93	1.16
CD (P=0.05)	0.60	0.65	0.44	0.87	1.38	0.81	NS	NS	3.23

\*Treatment details are in materials and methods

**Table 3:** Yield parameters as influenced by variety, panchagavya and vermiwash and their interaction in bitter gourd

	Yield per plant (kg)			Yield per plot (kg/5.4m <sup>2</sup> )			Yield per hectare (t/ha)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
<b>Varieties (V)</b>									
V <sub>1</sub>	0.87	0.93	0.90	5.22	5.61	5.41	8.70	9.35	9.02
V <sub>2</sub>	1.02	1.13	1.08	6.17	6.79	6.48	10.28	11.31	10.80
V <sub>3</sub>	1.46	1.60	1.53	8.76	9.64	9.20	14.61	16.07	15.34
S. Em (±)	0.01	0.01	0.00	0.03	0.05	0.03	0.05	0.08	0.05
CD (P=0.05)	0.01	0.02	0.01	0.09	0.13	0.08	0.15	0.22	0.13
<b>Panchagavya (P)</b>									
P <sub>0</sub>	0.96	1.07	1.01	5.75	6.40	6.07	9.58	10.67	10.12
P <sub>1</sub>	1.07	1.15	1.11	6.41	6.92	6.67	10.69	11.54	11.11
P <sub>2</sub>	1.14	1.26	1.20	6.86	7.55	7.21	11.44	12.58	12.01
P <sub>3</sub>	1.31	1.42	1.37	7.86	8.53	8.20	13.10	14.22	13.66
S. Em (±)	0.01	0.01	0.01	0.04	0.05	0.03	0.06	0.09	0.05
CD (P=0.05)	0.02	0.03	0.02	0.10	0.15	0.09	0.17	0.25	0.15
<b>Vermiwash (W)</b>									
W <sub>0</sub>	1.07	1.18	1.13	6.45	7.06	6.75	10.74	11.76	11.25
W <sub>1</sub>	1.13	1.24	1.18	6.75	7.42	7.09	11.26	12.37	11.81
W <sub>2</sub>	1.12	1.23	1.17	6.73	7.35	7.04	11.21	12.25	11.73
W <sub>3</sub>	1.16	1.26	1.21	6.95	7.57	7.26	11.59	12.62	12.11
S. Em (±)	0.01	0.01	0.01	0.04	0.05	0.03	0.06	0.09	0.05
CD (P=0.05)	0.02	0.03	0.02	0.10	0.15	0.09	0.17	0.25	0.15
<b>V X P X W</b>									
V <sub>1</sub> P <sub>0</sub> W <sub>0</sub>	0.59	0.63	0.61	3.52	3.77	3.65	5.87	6.29	6.08
V <sub>1</sub> P <sub>0</sub> W <sub>1</sub>	0.60	0.65	0.63	3.62	3.94	3.78	6.03	6.57	6.30
V <sub>1</sub> P <sub>0</sub> W <sub>2</sub>	0.61	0.69	0.65	3.65	4.11	3.88	6.08	6.85	6.47
V <sub>1</sub> P <sub>0</sub> W <sub>3</sub>	0.62	0.69	0.66	3.74	4.17	3.96	6.23	6.95	6.59
V <sub>1</sub> P <sub>1</sub> W <sub>0</sub>	0.75	0.82	0.79	4.49	4.92	4.71	7.49	8.20	7.85
V <sub>1</sub> P <sub>1</sub> W <sub>1</sub>	0.81	0.84	0.83	4.84	5.08	4.96	8.07	8.46	8.27
V <sub>1</sub> P <sub>1</sub> W <sub>2</sub>	0.85	0.93	0.89	5.09	5.59	5.34	8.48	9.32	8.90
V <sub>1</sub> P <sub>1</sub> W <sub>3</sub>	0.89	0.94	0.92	5.35	5.65	5.50	8.92	9.42	9.17
V <sub>1</sub> P <sub>2</sub> W <sub>0</sub>	0.85	0.94	0.90	5.09	5.61	5.36	8.48	9.36	8.92
V <sub>1</sub> P <sub>2</sub> W <sub>1</sub>	0.93	0.99	0.96	5.58	5.95	5.77	9.31	9.92	9.62
V <sub>1</sub> P <sub>2</sub> W <sub>2</sub>	1.05	1.08	1.06	6.26	6.44	6.36	10.44	10.74	10.59
V <sub>1</sub> P <sub>2</sub> W <sub>3</sub>	1.12	1.17	1.15	6.69	7.05	6.87	11.15	11.75	11.45
V <sub>1</sub> P <sub>3</sub> W <sub>0</sub>	1.05	1.13	1.10	6.29	6.82	6.56	10.49	11.36	10.93
V <sub>1</sub> P <sub>3</sub> W <sub>1</sub>	1.05	1.17	1.11	6.31	7.03	6.67	10.51	11.72	11.12
V <sub>1</sub> P <sub>3</sub> W <sub>2</sub>	1.08	1.16	1.12	6.47	6.97	6.72	10.78	11.61	11.20
V <sub>1</sub> P <sub>3</sub> W <sub>3</sub>	1.09	1.12	1.11	6.53	6.72	6.63	10.88	11.20	11.04
V <sub>2</sub> P <sub>0</sub> W <sub>0</sub>	1.11	1.16	1.14	6.64	6.98	6.81	11.07	11.63	11.35
V <sub>2</sub> P <sub>0</sub> W <sub>1</sub>	1.13	1.18	1.16	6.80	7.10	6.95	11.33	11.83	11.58
V <sub>2</sub> P <sub>0</sub> W <sub>2</sub>	0.90	1.09	1.00	5.39	6.53	5.96	8.99	10.89	9.94
V <sub>2</sub> P <sub>0</sub> W <sub>3</sub>	0.99	1.10	1.05	5.96	6.57	6.27	9.94	10.95	10.45

\*Treatment details are in materials and methods

**Table 4:** Interaction effect of variety, panchagavya and vermiwash on yield parameters in bitter gourd

	Yield per plant (kg)			Yield per plot (kg/5.4m <sup>2</sup> )			Yield per hectare (t/ha)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
V <sub>2</sub> P <sub>1</sub> W <sub>0</sub>	1.01	1.10	1.06	6.08	6.62	6.35	10.14	11.03	10.58
V <sub>2</sub> P <sub>1</sub> W <sub>1</sub>	1.03	1.10	1.07	6.18	6.60	6.39	10.29	11.00	10.65
V <sub>2</sub> P <sub>1</sub> W <sub>2</sub>	0.91	0.97	0.94	5.44	5.84	5.64	9.06	9.74	9.40
V <sub>2</sub> P <sub>1</sub> W <sub>3</sub>	0.94	1.01	0.98	5.64	6.05	5.85	9.40	10.08	9.74
V <sub>2</sub> P <sub>2</sub> W <sub>0</sub>	1.04	1.12	1.08	6.23	6.72	6.48	10.38	11.20	10.79
V <sub>2</sub> P <sub>2</sub> W <sub>1</sub>	1.11	1.30	1.20	6.66	7.77	7.22	11.10	12.94	12.02
V <sub>2</sub> P <sub>2</sub> W <sub>2</sub>	0.94	1.01	0.98	5.65	6.07	5.86	9.42	10.12	9.77
V <sub>2</sub> P <sub>2</sub> W <sub>3</sub>	1.01	1.08	1.05	6.05	6.50	6.28	10.08	10.82	10.46
V <sub>2</sub> P <sub>3</sub> W <sub>0</sub>	1.15	1.21	1.18	6.89	7.28	7.09	11.48	12.14	11.81
V <sub>2</sub> P <sub>3</sub> W <sub>1</sub>	1.16	1.27	1.22	6.96	7.60	7.28	11.59	12.67	12.13
V <sub>2</sub> P <sub>3</sub> W <sub>2</sub>	1.00	1.18	1.09	5.99	7.05	6.52	9.99	11.76	10.88
V <sub>2</sub> P <sub>3</sub> W <sub>3</sub>	1.03	1.22	1.13	6.17	7.36	6.77	10.28	12.26	11.27
V <sub>3</sub> P <sub>0</sub> W <sub>0</sub>	1.03	1.22	1.13	6.17	7.31	6.74	10.29	12.19	11.24
V <sub>3</sub> P <sub>0</sub> W <sub>1</sub>	1.08	1.38	1.23	6.48	8.29	7.39	10.81	13.82	12.32
V <sub>3</sub> P <sub>0</sub> W <sub>2</sub>	1.40	1.48	1.45	8.43	8.87	8.66	14.06	14.79	14.43
V <sub>3</sub> P <sub>0</sub> W <sub>3</sub>	1.42	1.53	1.48	8.53	9.16	8.85	14.23	15.26	14.74
V <sub>3</sub> P <sub>1</sub> W <sub>0</sub>	1.34	1.49	1.42	8.07	8.94	8.51	13.45	14.90	14.18
V <sub>3</sub> P <sub>1</sub> W <sub>1</sub>	1.38	1.50	1.44	8.27	9.01	8.64	13.78	15.01	14.40
V <sub>3</sub> P <sub>1</sub> W <sub>2</sub>	1.45	1.52	1.49	8.67	9.16	8.92	14.46	15.27	14.87

V <sub>3</sub> P <sub>1</sub> W <sub>3</sub>	1.47	1.60	1.54	8.82	9.60	9.21	14.71	16.00	15.35
V <sub>3</sub> P <sub>2</sub> W <sub>0</sub>	1.33	1.55	1.44	7.98	9.30	8.64	13.31	15.50	14.40
V <sub>3</sub> P <sub>2</sub> W <sub>1</sub>	1.44	1.57	1.51	8.65	9.40	9.03	14.42	15.67	15.05
V <sub>3</sub> P <sub>2</sub> W <sub>2</sub>	1.45	1.63	1.54	8.71	9.77	9.24	14.52	16.28	15.40
V <sub>3</sub> P <sub>2</sub> W <sub>3</sub>	1.46	1.67	1.57	8.77	10.00	9.39	14.62	16.67	15.65
V <sub>3</sub> P <sub>3</sub> W <sub>0</sub>	1.65	1.74	1.70	9.89	10.42	10.16	16.49	17.37	16.93
V <sub>3</sub> P <sub>3</sub> W <sub>1</sub>	1.78	1.88	1.83	10.71	11.29	11.00	17.84	18.81	18.33
V <sub>3</sub> P <sub>3</sub> W <sub>2</sub>	1.82	1.96	1.89	10.93	11.78	11.36	18.22	19.63	18.93
V <sub>3</sub> P <sub>3</sub> W <sub>3</sub>	1.86	2.01	1.94	11.19	12.05	11.62	18.65	20.08	19.37
S. Em (±)	0.02	0.03	0.02	0.12	0.19	0.11	0.21	0.31	0.19
CD (P=0.05)	0.06	0.09	0.05	0.35	0.52	0.31	0.59	0.87	0.52

\*Treatment details are in materials and methods

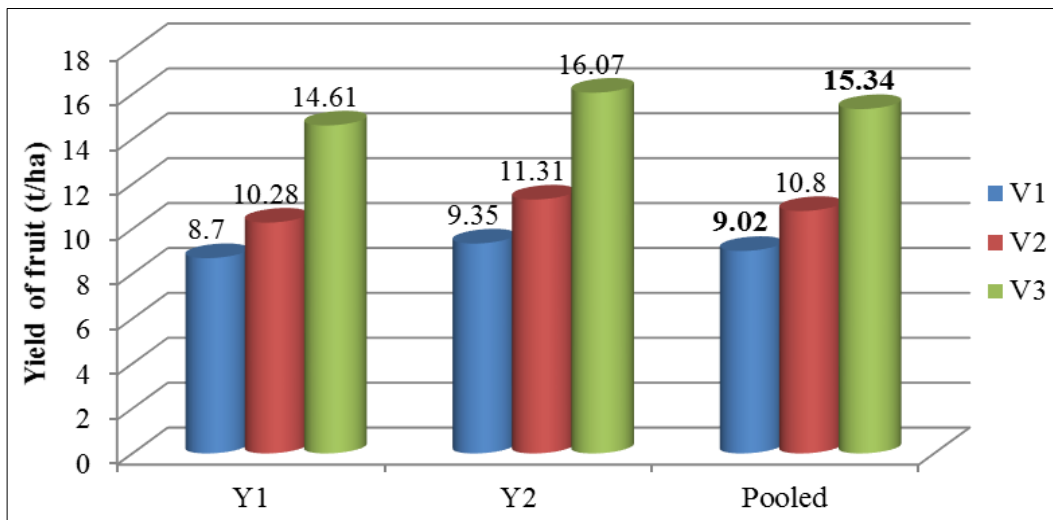


Fig 1: Individual effect of varieties on yield of fruit (t/ha)

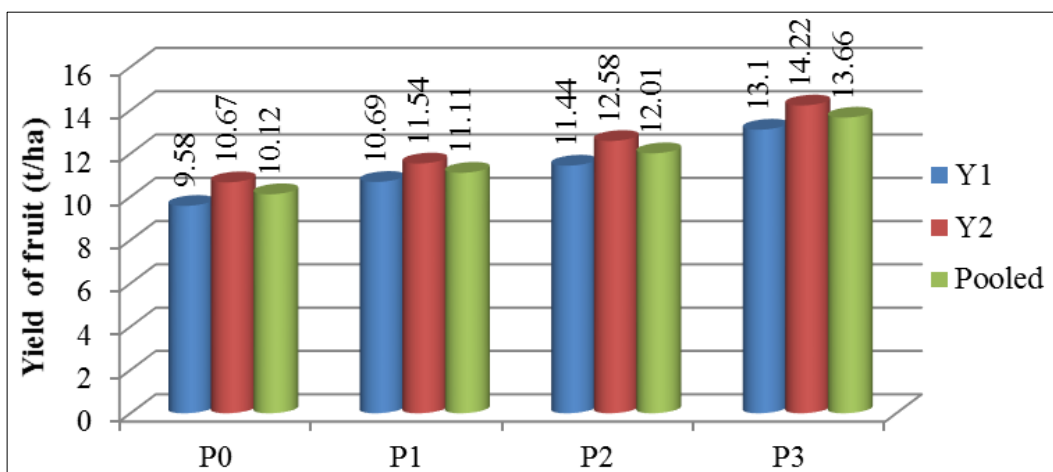


Fig 2: Individual effect of panchagavya on yield of fruit (t/ha)

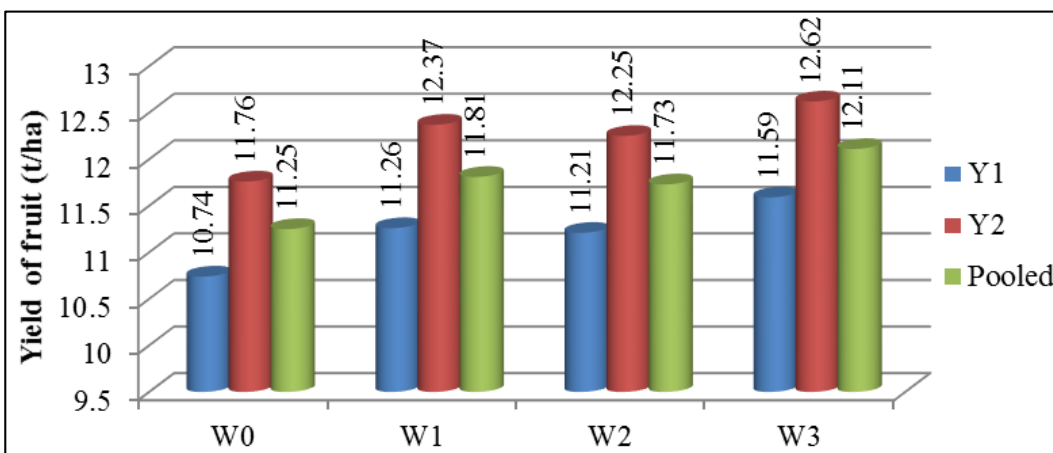


Fig 3: Individual effect of vermiwash on yield of fruit (t/ha)

**Table 5:** Quality parameters as influenced by variety, panchagavya and vermiwash and their interaction in bitter gourd

	TSS (°Brix)			Ascorbic acid (mg/100g)			Protein (%)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
<b>Varieties (V)</b>									
V <sub>1</sub>	1.08	1.38	1.23	70.56	72.03	71.30	1.24	1.32	1.28
V <sub>2</sub>	1.13	1.43	1.28	70.83	72.56	71.70	1.42	1.54	1.48
V <sub>3</sub>	1.54	1.84	1.69	73.04	74.60	73.82	1.43	1.56	1.49
S. Em (±)	0.01	0.01	0.01	0.43	0.42	0.29	0.00	0.01	0.00
CD (P=0.05)	0.04	0.04	0.03	1.21	1.17	0.82	0.01	0.02	0.01
<b>Panchagavya (P)</b>									
P <sub>0</sub>	1.10	1.43	1.27	58.92	60.43	59.68	1.29	1.37	1.33
P <sub>1</sub>	1.06	1.44	1.25	70.43	72.22	71.33	1.33	1.45	1.39
P <sub>2</sub>	1.31	1.49	1.40	74.48	76.11	75.30	1.39	1.51	1.45
P <sub>3</sub>	1.56	1.86	1.70	82.09	83.51	82.80	1.46	1.58	1.52
S. Em (±)	0.02	0.02	0.02	0.50	0.48	0.34	0.01	0.01	0.01
CD (P=0.05)	0.04	0.04	0.07	1.40	1.35	0.95	0.02	0.02	0.02
<b>Vermiwash (W)</b>									
W <sub>0</sub>	1.19	1.49	1.34	68.39	70.07	69.23	1.34	1.45	1.40
W <sub>1</sub>	1.23	1.53	1.38	70.28	72.04	71.16	1.36	1.47	1.42
W <sub>2</sub>	1.27	1.57	1.42	72.75	74.16	73.46	1.37	1.49	1.43
W <sub>3</sub>	1.33	1.63	1.48	74.50	76.01	75.26	1.39	1.51	1.45
S. Em (±)	0.02	0.02	0.02	0.50	0.48	0.34	0.01	0.01	0.01
CD (P=0.05)	0.04	0.04	0.07	1.40	1.35	0.95	0.02	0.02	0.02
<b>V X P X W</b>									
V <sub>1</sub> P <sub>0</sub> W <sub>0</sub>	0.82	1.12	0.97	55.26	56.20	55.73	1.06	1.06	1.06
V <sub>1</sub> P <sub>0</sub> W <sub>1</sub>	0.84	1.14	0.99	56.34	57.75	57.05	1.11	1.12	1.12
V <sub>1</sub> P <sub>0</sub> W <sub>2</sub>	0.86	1.16	1.01	57.81	58.60	58.21	1.14	1.15	1.15
V <sub>1</sub> P <sub>0</sub> W <sub>3</sub>	0.86	1.16	1.01	62.45	63.36	62.91	1.15	1.17	1.16
V <sub>1</sub> P <sub>1</sub> W <sub>0</sub>	0.95	1.25	1.10	65.20	66.55	65.88	1.31	1.41	1.36
V <sub>1</sub> P <sub>1</sub> W <sub>1</sub>	0.97	1.27	1.12	66.55	68.75	67.65	1.31	1.42	1.37
V <sub>1</sub> P <sub>1</sub> W <sub>2</sub>	1.03	1.33	1.18	70.07	71.65	70.86	1.32	1.45	1.39
V <sub>1</sub> P <sub>1</sub> W <sub>3</sub>	1.10	1.40	1.25	71.80	73.98	72.89	1.32	1.45	1.39
V <sub>1</sub> P <sub>2</sub> W <sub>0</sub>	1.20	1.50	1.35	73.39	74.59	73.99	1.34	1.46	1.40
V <sub>1</sub> P <sub>2</sub> W <sub>1</sub>	1.30	1.60	1.45	73.72	75.26	74.49	1.35	1.49	1.42
V <sub>1</sub> P <sub>2</sub> W <sub>2</sub>	1.10	1.40	1.25	74.46	76.27	75.37	1.22	1.32	1.27
V <sub>1</sub> P <sub>2</sub> W <sub>3</sub>	1.17	1.47	1.32	74.70	76.53	75.62	1.23	1.32	1.28
V <sub>1</sub> P <sub>3</sub> W <sub>0</sub>	1.17	1.47	1.32	75.94	78.47	77.21	1.24	1.33	1.29
V <sub>1</sub> P <sub>3</sub> W <sub>1</sub>	1.20	1.50	1.35	81.36	82.51	81.94	1.25	1.33	1.29
V <sub>1</sub> P <sub>3</sub> W <sub>2</sub>	1.27	1.57	1.42	84.35	85.63	84.99	1.26	1.35	1.31
V <sub>1</sub> P <sub>3</sub> W <sub>3</sub>	1.53	1.83	1.68	85.69	86.41	86.05	1.26	1.36	1.31
V <sub>2</sub> P <sub>0</sub> W <sub>0</sub>	0.81	1.11	0.96	53.34	55.31	54.33	1.27	1.36	1.32
V <sub>2</sub> P <sub>0</sub> W <sub>1</sub>	0.84	1.14	0.99	55.62	57.49	56.56	1.28	1.37	1.33
V <sub>2</sub> P <sub>0</sub> W <sub>2</sub>	0.85	1.15	1.00	62.94	65.11	64.03	1.29	1.38	1.34
V <sub>2</sub> P <sub>0</sub> W <sub>3</sub>	0.88	1.18	1.03	64.64	66.57	65.61	1.30	1.39	1.35

\*Treatment details are in materials and method

**Table 6:** Interaction effect of variety, panchagavya and vermiwash on quality parameters in bitter gourd

	TSS (°Brix)			Ascorbic acid (mg/100g)			Protein (%)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
V <sub>2</sub> P <sub>1</sub> W <sub>0</sub>	0.87	1.17	1.02	69.09	70.55	69.82	1.50	1.63	1.57
V <sub>2</sub> P <sub>1</sub> W <sub>1</sub>	0.93	1.23	1.08	69.50	71.43	70.47	1.51	1.64	1.58
V <sub>2</sub> P <sub>1</sub> W <sub>2</sub>	0.93	1.23	1.08	69.66	71.60	70.63	1.51	1.65	1.58
V <sub>2</sub> P <sub>1</sub> W <sub>3</sub>	0.97	1.27	1.12	70.38	72.50	71.44	1.53	1.68	1.61
V <sub>2</sub> P <sub>2</sub> W <sub>0</sub>	1.10	1.40	1.25	71.05	73.05	72.05	1.57	1.71	1.64
V <sub>2</sub> P <sub>2</sub> W <sub>1</sub>	1.10	1.40	1.25	71.42	73.53	72.48	1.60	1.72	1.66
V <sub>2</sub> P <sub>2</sub> W <sub>2</sub>	1.37	1.67	1.52	74.46	76.16	75.31	1.36	1.49	1.43
V <sub>2</sub> P <sub>2</sub> W <sub>3</sub>	1.43	1.73	1.58	75.90	76.99	76.45	1.37	1.53	1.45
V <sub>2</sub> P <sub>3</sub> W <sub>0</sub>	1.47	1.77	1.62	76.76	78.41	77.59	1.38	1.54	1.46
V <sub>2</sub> P <sub>3</sub> W <sub>1</sub>	1.53	1.83	1.68	81.25	82.39	81.82	1.40	1.55	1.48
V <sub>2</sub> P <sub>3</sub> W <sub>2</sub>	1.54	1.84	1.69	84.85	85.86	85.36	1.42	1.56	1.49
V <sub>2</sub> P <sub>3</sub> W <sub>3</sub>	1.58	1.88	1.73	82.52	84.13	83.33	1.43	1.57	1.50
V <sub>3</sub> P <sub>0</sub> W <sub>0</sub>	1.53	1.93	1.73	52.41	53.77	53.09	1.44	1.58	1.51
V <sub>3</sub> P <sub>0</sub> W <sub>1</sub>	1.57	1.97	1.77	56.93	58.94	57.94	1.45	1.61	1.53
V <sub>3</sub> P <sub>0</sub> W <sub>2</sub>	1.63	2.07	1.85	60.29	61.41	60.85	1.45	1.62	1.54
V <sub>3</sub> P <sub>0</sub> W <sub>3</sub>	1.67	2.07	1.87	69.05	70.64	69.85	1.49	1.62	1.56
V <sub>3</sub> P <sub>1</sub> W <sub>0</sub>	1.40	1.70	1.55	71.22	73.47	72.35	1.16	1.20	1.18
V <sub>3</sub> P <sub>1</sub> W <sub>1</sub>	1.47	1.77	1.62	72.97	74.71	73.84	1.17	1.25	1.21
V <sub>3</sub> P <sub>1</sub> W <sub>2</sub>	1.06	1.83	1.45	74.02	75.21	74.62	1.17	1.27	1.22

V <sub>3</sub> P <sub>1</sub> W <sub>3</sub>	1.07	1.87	1.47	74.71	76.26	75.49	1.19	1.29	1.24
V <sub>3</sub> P <sub>2</sub> W <sub>0</sub>	1.17	1.36	1.27	75.24	76.81	76.03	1.20	1.31	1.26
V <sub>3</sub> P <sub>2</sub> W <sub>1</sub>	1.23	1.37	1.30	75.83	77.26	76.55	1.21	1.32	1.27
V <sub>3</sub> P <sub>2</sub> W <sub>2</sub>	1.77	1.47	1.62	76.37	78.06	77.22	1.61	1.73	1.67
V <sub>3</sub> P <sub>2</sub> W <sub>3</sub>	1.77	1.53	1.65	77.22	78.84	78.03	1.64	1.76	1.70
V <sub>3</sub> P <sub>3</sub> W <sub>0</sub>	1.80	2.10	1.95	81.75	83.70	82.73	1.66	1.80	1.73
V <sub>3</sub> P <sub>3</sub> W <sub>1</sub>	1.80	2.10	1.95	81.92	84.40	83.16	1.68	1.81	1.75
V <sub>3</sub> P <sub>3</sub> W <sub>2</sub>	1.84	2.14	1.99	83.75	84.35	84.05	1.72	1.85	1.79
V <sub>3</sub> P <sub>3</sub> W <sub>3</sub>	1.92	2.22	2.07	84.99	85.88	85.44	1.78	1.94	1.86
S. Em (±)	0.05	0.05	0.04	1.72	1.66	1.18	0.02	0.02	0.02
CD (P=0.05)	0.15	0.15	0.11	NS	NS	3.29	0.05	0.07	0.04

\*Treatment details are in materials and methods

## Conclusions

We have conducted this experiment for two consecutive years and from the experimental findings it can be concluded that the variety Gangajal-1 should be selected for organic bitter gourd cultivation. In addition to normal organic nutrient schedule (*Azotobacter* (5kg) enriched FYM at 20 t/ha, as basal dose and Vermicompost at 5 t/ha as top dressing at 30 DAS), the bitter gourd crop should be provided 3 sprays of Panchagavya (3%) at 20, 40 and 60 DAS as well as Vermiwash (10%) at 25, 50 and 75 DAS. The practice will not only increase the yield of organic bitter gourd but also improve the fruit quality and enhance the shelf life of the fruits, simultaneously it will make the production system more sustainable in long run.

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