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Effect of various cow-based bio-enhancers and botanicals on growth, yield and quality of organic wheat

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Abstract

An experiment was conducted on medium black calcareous clayey soil at Junagadh (Gujarat) in *rabi* 2016-17 and 2017-18. Twelve treatments comprising *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS, *Jivamrut* @ 500 L/ha with irrigation at sowing, 30, 45 and 60 DAS, Banana sap as foliar spray @ 1% at 30, 45 and 60 DAS and Seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS were evaluated alone and supplemented with FYM 6 t/ha) in comparison to Vermi compost 4 t/ha + FYM 6 t/ha + Bio fertilizers, FYM 24 t/ha, Control and 100% RDF (outside the organic plot) in randomized block design with three replications. The experimental results revealed that next to 100% RDF, application of FYM 24 t/ha and *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS + FYM 6 t/ha were found superior in respect of the growth parameters and yield attributes along with higher grain yield (4148 and 3877 kg/ha), straw yields (6383 and 6176 kg/ha) and application of Vermi compost 4 t/ha + FYM 6 t/ha + Bio fertilizers enhanced grain protein.

Keywords: Wheat, *Panchagavya*, *jivamrut*, seaweed extract, banana sap, organic farming

Introduction

Wheat (*Triticum aestivum* L.) is the second most important cereal crop next to rice in the world belongs to the family *Poaceae*. It is the leading cereal grain, where 40% of the world population uses as a staple food (Anon., 2007) [1]. Its increasing demand, day by day, is due to increase in the population of India.

India is predominantly an agricultural country and green revolution has brought a significant change in Indian agriculture. The achievements were mainly due to use of high yielding varieties, fertilizer responsive crop cultivars and increased fertilizer use. There is a keen awareness worldwide in recent years on the excess use of chemical fertilizers and other chemicals leading to environmental pollution and pest outbreaks. Sustained production strategies often involve application of organic sources.

With increased awareness on organic farming among the farming community, they are using of many organic formulations in crop production. During the last few years there has been increasing interest in the use of *Panchagavya*, *Jivamrut* and other liquid organic formulations. *Panchagavya* and *Jivamrut* are two organic products which have received wide spread attention and acceptability among organic farming practitioners.

Application of cow-based bio-enhancers, botanicals, organic manures and bio fertilizers such as *Panchagavya*, *Jivamrut*, banana sap, seaweed extract, cattle manure, vermi compost and *Azotobacter*, PSB and KSB has led to a decrease in the use of chemical fertilizers and has provided high quality products free of harmful agrochemicals for human safety.

Materials and methods

A field experiment titled "The effect of various cow-based bio-enhancers and botanicals on growth, yield and quality of organic wheat" was carried out at Certified Organic Farming Plot of Instructional Farm, College of Agriculture, JAU, Junagadh during *rabi* season of the year 2016-17 and 2017-18 on clayey soil.

Twelve treatments comprising *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS, *Jivamrut* @ 500 L/ha with irrigation at sowing, 30, 45 and 60 DAS, Banana sap as foliar spray @ 1% at 30, 45 and 60 DAS and Seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS were evaluated alone and supplemented with FYM 6 t/ha) in comparison to Vermi compost 4 t/ha + FYM 6 t/ha + Bio fertilizers, FYM 24 t/ha, Control and 100% RDF (outside

the organic plot) in randomized block design with three replications. All the recommended cultural operations were followed throughout the experimentation. Irrigation to 5 cm depth applied during cropping period. Five random plants were selected from each plot excluding the border row for taking observation on growth, yield and quality parameters. The data were subjected to statistical analysis by adopting appropriate analysis of variance as described by Cochran and Cox (1967) [3].

Preparation of *Panchagavya*

A wide mouth plastic container was taken. It was clean and sun-dried for a day or two to sterilize it. Then the cow dung (7kg) and ghee (1kg) were mixed in the container using a wooden stick. It was stirred clockwise direction in a rhythmic motion. Then it stirred in anti-clockwise direction. The container was covered using thick cloth to protect it from insects. This mixture was left for three days. After 3 days cow urine (10L) and water (10L) were mixed than kept for 15 days with regular mixing both in morning and evening hours. After 15 days cow milk (3L), cow curd (2L), tender coconut water (3L), jaggery (3kg) and well ripened banana (12no.) were mixed. *Panchagavya* was ready after 30 days.

Preparation of *Jivamrut*

Jivamrut was prepared by mixing 10kg *desi* cow dung, 10L cow urine, 2kg jaggery, 2kg pigeon pea flour and hand full of soil collected from rhizosphere of Banyan tree. All these were put in 200L capacity plastic drum and mixed thoroughly and volume was made up to 200L. The mixture was stirred well in clock wise direction and kept in shade covered with wet jute bag up to nine days and it was used for soil application.

Results and discussion

Effect on growth attributes

Growth parameters *viz.*, plant height and number of tillers per m row length at harvest (Table 1) were significantly influenced by different treatments.

Besides the treatment 100% RDF, significantly the highest value of the plant height at harvest (91.52cm) and number of tillers per m row length at harvest (57.67) were observed with the treatment of FYM 24 t/ha in pooled results, which was at par with *Jivamrut* @ 500 L/ha with irrigation at sowing, 30, 45 and 60 DAS + FYM 6 t/ha, *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS + FYM 6 t/ha, Banana sap as foliar spray @ 1% at 30, 45 and 60 DAS + FYM 6 t/ha and Vermi compost 4 t/ha + FYM 6 t/ha + Bio fertilizers (*Azotobacter* + PSB + KSB) in most of the cases. While, the lowest value of these growth parameters were observed in the control treatment.

Among the different cow-based bio-enhancers and botanicals treatments, the highest plant height at harvest and number of tillers per m row length at harvest were observed with the treatment of *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS + FYM 6 t/ha. *Panchagavya* is the fermented organic liquid manure with high microbial load, which includes effective microorganisms and methyl trophs profile bacteria also. These would have enhanced the production of phyto hormones like auxins and gibberellins. The increase in plant height might be due to application of nutrients through foliar spray of *Panchagavya* enhanced the growth rate of plant since it contains the favourable macro and micro nutrients, growth hormones and bio fertilizers in liquid formulation. Similar findings have been reported by Kumar *et al.* (2011) and Sahare (2015).

Effect on yield attributes

The significant effect of different treatments was reflected on yield attributes (Table 1). Next to 100% RDF, the treatment FYM 24t/ha, excelled yield attributes *viz.*, number of effective tillers per m row length (54.17), length of spike (6.97cm), number of spikelets per spike (12.87), number of grains per spike (34.78), grain weight per spike (2.27g), grain weight per plant (10.58g), 1000-grain weight (53.20g) and 1000-grain volume (42.60ml) in pooled result, followed by *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS+FYM 6 t/ha, *Jivamrut* @ 500L/ha with irrigation at sowing, 30, 45 and 60 DAS+FYM 6t/ha and Banana sap as foliar spray @ 1% at 30, 45 and 60 DAS+FYM 6t/ha. However, significantly the lowest values of these yield attributes were recorded under the control.

In case of organic cultivation, the treatment *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS+FYM 6 t/ha found superior than other cow-based bio-enhancers and botanicals, followed by *Jivamrut* @ 500L/ha with irrigation at sowing, 30, 45 and 60 DAS + FYM 6 t/ha. The increase in spikelets per spike and number of grains per spike due to *Panchagavya* might be due to accumulated metabolites which get translocated towards the reproductive sinks and these in turn resulted in stimulation of different yield attributes. The increase in the grain weight per spike might be due to the better availability of nutrients which enabled the increased yield. The IAA and GA present in *Panchagavya* when applied as foliar spray could have hastened length of spike resulting in maximum number of spikelets and ultimately grain setting. The present findings are in accordance with those reported earlier by Yadav and Christopher (2006) [9] and Ravichandran *et al.* (2011) [5]

Table 1: Effect of different treatments on growth and yield attributes of wheat (Pooled over two years)

Treatment	Plant height at harvest (cm)	Total tiller / m row at harvest	Effective tillers / m row length	Length of spike (cm)	Spikelet's per spike	Grains per spike	Grain weight / spike (g)	Grain weight / plant (g)	1000-grain weight (g)	1000-grain volume (ml)
T1: <i>Panchagavya</i> @ 3%	82.00	51.67	47.67	6.18	11.33	31.20	2.06	8.66	47.26	35.73
T2: <i>Panchagavya</i> @ 3%+FYM 6 t/ha	91.02	56.50	52.33	6.36	12.18	33.49	2.23	10.08	52.23	41.18
T3: <i>Jivamrut</i> @ 500 L/ha	85.46	50.83	46.83	6.17	11.23	30.97	2.06	8.52	46.60	35.48
T4: <i>Jivamrut</i> @ 500 + FYM 6 t/ha	83.17	56.83	52.50	6.32	11.60	31.83	2.17	9.27	51.43	39.45
T5: Banana sa @ 1%	81.67	48.50	44.33	5.88	10.90	30.24	1.95	8.30	45.57	35.05
T6: Banana sap @ 1% + FYM 6 t/ha	82.83	52.67	48.83	6.24	11.30	31.37	2.13	8.92	48.53	38.80
T7: Seaweed extract @	80.27	47.33	46.33	6.08	10.77	28.77	1.95	8.29	46.68	33.32

3.5%										
T ₈ : Seaweed extract @ 3.5% + FYM 6 t/ha	82.43	52.17	48.17	6.19	11.39	31.27	2.10	8.83	47.18	36.38
T ₉ : Vermi compost 4 t/ha + FYM 6 t/ha + Bio fertilizers	89.55	53.83	49.67	6.26	11.53	32.14	2.13	9.03	48.58	39.15
T ₁₀ : FYM 24 t/ha	91.52	57.67	54.17	6.97	12.87	34.78	2.27	10.58	53.20	42.60
T ₁₁ : 100% RDF	92.23	61.33	57.00	7.43	13.88	36.29	2.33	11.08	54.82	44.37
T ₁₂ : Control	64.90	37.33	33.33	4.87	8.80	24.88	1.56	5.09	36.91	29.31
S.Em.±	1.84	2.18	2.00	0.17	0.40	0.84	0.08	0.20	2.15	1.51
C.D. at 5%	5.26	6.22	5.71	0.47	1.15	2.40	0.23	0.56	6.13	4.32
C.V.%	5.38	10.23	10.12	6.53	8.61	6.55	9.51	5.39	10.92	9.87

Effect on crop yield

A close perusal of data on grain yield, straw yield and harvest index revealed that different treatments significantly influenced the grain and straw yields (Table 2) of wheat in 2017, 2018 and pooled results, while harvest index was not significantly influenced by different treatments.

Next to 100% RDF, higher grain yield was noticed under the treatments of FYM 24t/ha (4067, 4228 and 4148kg/ha during 2017, 2018 and pooled results, respectively), followed by *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS+FYM 6t/ha. Similarly, higher straw yield of wheat was recorded under FYM 24t/ha (6728, 6037 and 6383ab kg/ha during 2017, 2018 and pooled results, respectively) and *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS+FYM 6 t/ha besides 100% RDF. Organic point of view, grain and straw yields of wheat were significantly increased by *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS+FYM 6t/ha, followed by *Jivamrut* @ 500L/ha with irrigation at sowing, 30, 45 and 60 DAS+FYM 6 t/ha, which might be due to an enhanced release of growth promoting substances produced by the microbes present in *Panchagavya*. Adequate quantity of enzymes present in the cells might have favoured rapid growth and yield. FYM might have improved the biochemical properties of the soil and increased the activities of beneficial microorganisms which resulted in to production of growth promoting substances and improved nutrient availability for longer period and thus, beneficial

effects on growth and yield parameters of wheat. The overall improvement of crop growth reflected into better source-sink relationship, which in turn enhanced the grain and straw yields. The present findings are in close agreement with the results obtained by Shubha *et al.* (2014) [7], and Basavaraj *et al.* (2015) [2].

Effect on grain protein

Grain protein content (Table 2) significantly improved under the treatment comprising of Vermi compost 4t/ha + FYM 6 t/ha+ Bio fertilizers (*Azotobacter* + PSB+KSB) (13.44%), which remained statistically at par with FYM 24 t/ha, 100% RDF, *Jivamrut* @ 500L/ha with irrigation at sowing, 30, 45 and 60 DAS+FYM 6 t/ha, Seaweed extract as foliar spray @ 3.5% at 30, 45 and 60 DAS+FYM 6 t/ha and *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS + FYM 6 t/ha over control.

Significant improvement in grain protein content might be due to its dependence on nitrogen content. In the present investigation, higher nitrogen content in grain were recorded with the above mentioned treatments and enhanced photosynthetic and metabolic activity resulting in better partitioning of photosynthates to sinks, which reflected in quality enhancement in term of protein content. This finding closely associated with those of Singh and Kumar (2010) [8] and Yousefi and Berzegar (2014) [10].

Table 2: Effect of different treatments on grain yield, straw yields, harvest index and protein content of grain

Treatment	Grain yield (kg/ha)			Straw yield (kg/ha)			Harvest index	Protein content (%)
	2017	2018	Pooled	2017	2018	Pooled	Pooled	Pooled
T ₁ : <i>Panchagavya</i> @ 3%	3054 ^{bc}	3074 ^{bc}	3064 ^{bc}	5005 ^d	5000 ^{bc}	5002 ^{de}	38.06	11.07
T ₂ : <i>Panchagavya</i> @ 3% +FYM 6 t/ha	3778 ^{ab}	3975 ^{ab}	3877 ^{ab}	6444 ^{abc}	5907 ^{ab}	6176 ^{abc}	38.78	11.77
T ₃ : <i>Jivamrut</i> @ 500 L/ha	3053 ^{bc}	3055 ^{bc}	3054 ^{bc}	5038 ^d	4870 ^{bc}	4954 ^{de}	38.20	11.45
T ₄ : <i>Jivamrut</i> @ 500 +FYM 6 t/ha	3101 ^{bc}	3358 ^b	3229 ^{bc}	5852 ^{bcd}	5654 ^{ab}	5753 ^{bcd}	36.04	12.53
T ₅ : Banana sap @ 1%	2920 ^{bc}	3160 ^{bc}	3040 ^c	5549 ^{bcd}	5056 ^{bc}	5302 ^{cde}	36.49	11.35
T ₆ : Banana sap @ 1% +FYM 6 t/ha	3071 ^{bc}	3172 ^{bc}	3122 ^{bc}	4753 ^{de}	4833 ^{bc}	4793 ^e	39.43	11.04
T ₇ : Seaweed extract @ 3.5%	2934 ^{bc}	3030 ^{bc}	2982 ^c	5084 ^d	4778 ^{bc}	4931 ^{de}	37.90	11.16
T ₈ : Seaweed extract @ 3.5% + FYM 6 t/ha	3066 ^{bc}	3129 ^{bc}	3098 ^{bc}	5000 ^d	5099 ^{bc}	5049 ^{de}	38.03	11.96
T ₉ : Vermi compost 4 t/ha + FYM 6 t/ha + Bio fertilizers	3087 ^{bc}	3216 ^b	3151 ^{bc}	5420 ^{cd}	5142 ^{bc}	5281 ^{de}	37.43	13.44
T ₁₀ : FYM 24 t/ha	4067 ^a	4228 ^a	4148 ^a	6728 ^{ab}	6037 ^{ab}	6383 ^{ab}	39.70	13.16
T ₁₁ : 100% RDF	4395 ^a	4438 ^a	4416 ^a	7352 ^a	6741 ^a	7046 ^a	38.56	12.98
T ₁₂ : Control	2623 ^c	2629 ^c	2626 ^c	3732 ^e	3877 ^c	3804 ^f	40.88	9.82
S.Em.±	152	165	112	350	397	265	1.17	0.35
C.D. at 5%	446	484	320	1027	1165	755	NS	1.00
C.V.%	11.03	13.11	8.28	11.03	13.11	12.07	7.51	7.24

Note: Treatment means with the letter/letters in common are not significant by Duncan's New Multiple Rang Test at 5% level of significance

Conclusion

On the basis of the results obtained from the present two-year field experimentation, it seems quite logical to conclude that higher growth attributes, yield attributes and yield of wheat

(var. GW-366) under organic farming can be secured by application of *Panchagavya* as foliar spray @ 3% at 30, 45 and 60 DAS along with FYM 6 t/ha on clayey soil of South Saurashtra Agro-climatic Zone.

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