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Research Paper

Effect of organic farming practices on growth, yield, quality and economics of onion (*Allium cepa*) in dry zone of Karnataka

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ABSTRACT

The field experiment was conducted during summer 2012 and winter season (*rabi*) of 2012–13 to study the effect of different sources of organic manures on growth, yield, quality and economics of onion (*Allium cepa* L.). The experiment was carried out in organic experimental plot at Zonal Agriculture Research Station, GKVK, Bengaluru, under organic crop production. There were 13 treatments, comprising basal application of farmyard manure, vermicompost, biodigested and enriched biodigested liquid manures (BDLM and EBDLM applied after swoing in 3 splits), 3 sprays of 3% panchagavya (PG) and vermiwash (VW). Application of enriched biodigested liquid manure (EBDLM) at 100 kg N equivalent/ha + 3 sprays of panchagavya (3%) recorded the highest plant height (42.3 cm), leaves/plant (8.1), leaf diameter (1.46 cm), leaf-area index (4.26), total dry matter production/plant (7.59 g), fresh weight of bulb (143.7 g), bulb yield (42.8 tonnes/ha), neck diameter (1.42 cm), bulb diameter (6.02 cm), bulb length (5.36 cm), bulb size index (32.26 cm^2/bulb), ascorbic acid (26.1 mg/100 g), total soluble solid (14.4%), reducing sugar (3.98%), non-reducing sugar (9.05%), total sugar (13.03 %), gross returns (₹4,72,000), net returns (₹3,61,557) and benefit: cost ratio (4.27).

Key words **:** Crop production**,** Enriched biodigested liquid manure, Onion, Organic farming, Panchagavya, Vermiwash

Consumer demand for organically grown vegetables is markedly increasing all over the world for both domestic and export markets. This drastic change is due to human's concern over health, which made him to produce free from harmful chemical residues. The challenges are how to produce these crops in ways that are environmentally friendly and without lowering the yield levels achieved under recommended package of practices. Onion is one of the major bulb crops of the world and one of the most important vegetable as well as spice crops grown for commercial purpose. India stands second (17.51 million tonnes) in global production after China (24.76 million tonnes) occupying 1.09 million ha with a productivity of 16.10 tonnes/ha. India contributes 12.5% to global onion production (www.indiastat.com, 2012). Large yellow and small rose red onions are grown in eastern dry zone of Karnataka for export purpose. Organically produced crops possess better biochemical and physical quality (Prabhakar *et al*., 2012). Conventional organic manures, viz. farmyard manure/compost with low nutrient content and application rate coupled with slow nutrient release pattern could not satisfy the crop demand. Hence an attempt was made to develop liquid organic nutrient source which can meet temporal as well as quantitative crop nutrient demand. Further indigenous organic additives are integrated and response was assessed in terms of yield and quality of onion.

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MATERIALS AND METHODS

The field experiment was conducted during summer 2012 and winter (*rabi*) 2012 at GKVK Farm, Bengaluru, Karnataka. The soil was sandy clay loam (coarse sand 33.2%, fine sand 36.4%, silt 7.4% and clay 23.0%), slightly acidic (5.78) with an electrical conductivity of 0.16 dS/m. The organic carbon content of soil was 0.50 % with 298.0, 26.5 and 160.0 kg N, P_2O_5 and K_2O/ha respectively. There were 12 treatments comprising biodigested liquid manures, enriched biodigested liquid manures each at 75 and 100 kg N equivalent with and without foliar application of panchagavya and vermiwash as detailed in Table 1. Recommended manurial practices (30 tonnes FYM/compost + 125 kg N, 50 kg P_2O_5 and 75 kg K_2O/ha)

was included as the control. The experiment was laid out in randomized complete block design with 3 replications. The gross and net plot size was 3.0 m × 3.3 m and 2.2 m × 2.9 m respectively. Entire quantity of recommended P and K with 50% recommended N was applied at basal. While 25% recommended N each was top-dressed at 30 and 50 days after sowing. The seeds of 'Arka Kalyan' onion cultivar was sown on 5 January 2012 and 3 September 2012 in rows, later thinned between 13–15 days retaining one seedling at 10 cm inter-row space and 20 cm intra-row space. The treatments comprising liquid manures received 30 tonnes FYM + 2.5 tonnes vermicompost/ha as a basal dose along with biofertilizers (*Azospirillum* + Phosphorus-solubilizing bacteria). Biodigested liquid manures (BDLM), enriched biodigested liquid manures (EBDLM) were applied to soil in 3 splits–30, 60 and 75 days after sowing (2.3, 3.1, 2.1 and 2.8 litres/split/plot for T_1 to T_3, T_4 to T_6, T_7 to T_9 and T_{10} to T_{12} respectively as per table 2). Panchagavya and vermiwash were sprayed on the foliage at 3% in 3 sprays at 30, 60 and 75 days after sowing. The biodigested liquid manure was prepared in a 200 litres cement tank using 30 kg *Gliricidia* green biomass, 15 kg fresh cowdung, 20 litres cow urine with 100 litres water. The contents were incubated for 45 days, enriched biodigested liquid manures (EBDLM) was prepared by adding *Pongamia pinnata* seed cake at the rate of 10%. All the manurial sources used were analyzed for their nutrient concentration (Table 1) and the total quantity of liquid manure required was computed on N-equivalent basis. Panchagavya was prepared by mixing fresh cowdung (7 kg) and *ghee* (1 kg) in a plastic container and the contents were incubated for 2 days. On the third day, 1 litre cow urine and 10 litres water were added, fermented for 12 days. Then, 2 litres each curd, milk and tender coconut water, 100 g yeast, 250 g chemical free jaggery and 12 well-ripped bananas were added. The contents were stirred thrice in a day for 15 days. The material was filtered through thin cotton cloth and was used as foliar spray at 3%. Vermiwash was prepared by dipping adult earth worms in luke warm water for 5–7 minutes at 1 litre/kg worms. The crop was harvested on 17 May 2012 and 11 February 2013. The total rainfall received during cropping period was 93.4 mm and 263.8 mm in summer and *rabi* season respectively. The crop was irrigated on the day after sowing and subsequent irrigations were given at an interval of 4 - 5 days. Organic plant protection was taken up using *T. harzianum* and *P. florescence* for management of alternaria purple blotch, while neem oil at 2% used for the management of thrips incidence.

Leaf-area index (LAI) and leaf-area duration were calculated by adapting the procedure given by Watson (1953) at 30, 60, 90, 120 days after sowing and at harvest. The neck diameter, diameter and length of bulbs were recorded by using vernier calipers and expressed in centimeter. Bulb size index (cm^2) was computed by multiplying the length and diameter of bulb.

Ascorbic acid content of onion bulb was estimated by using 2, 6-dichlorophenol indophenol dye solution (Sadasivam and Manickam, 2004). The total soluble solid was estimated in fresh onion bulb. The juice obtained from the fresh bulbs was observed for total soluble solids using hand refractometer (0–30°) and expressed in per cent (Niewhof *et al.,* 1973).

Reducing, non-reducing and total sugars in onion bulbs were estimated and expressed in percentage (Lal Singh, 1987). Economics was also calculated. The pooled data were statistical analysed using Fisher's method of analysis of variance as outlined by Gomez and Gomez (1983).

RESULTS AND DISCUSSION

Growth attributes

Application of EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya at 3% recorded the highest plant height, number of leaves/plant, leaf diameter, leaf-area index, and total dry-matter production/plant than all other treatments except T_{10}, T_{11} and T_{13} (Table 2). Application of BDLM at 75 kg N eq./ha recorded the minimum values for all these characters. Enriched BDLM use along with foliar spray of

Table 1. Nutrient composition of different organic manures

Types of BDLM	pH	Electrical conductivity (dS/m)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Cu (ppm)	Zn (ppm)	Fe (ppm)	Mn (ppm)
Farmyard manure	8.2	0.17	0.58	0.31	0.43	0.18	0.13	0.10	33.0	13.0	21.0	27.0
Vermicompost	7.49	0.46	1.8	0.91	1.01	0.21	0.16	0.17	44.2	18.3	36.2	38.4
Pongamia cake	5.51	0.52	1.92	0.95	1.0	0.25	0.17	0.18	22.0	59.0	1000.0	74.0
Glyricidia	7.3	0.05	1.06	0.23	0.35	0.07	0.06	0.34	1.20	1.78	17.2	2.65
Glyricidia EBDLM	7.5	0.08	1.18	0.3	0.49	0.15	0.08	0.38	2.18	22.6	3.10	2.06
Panchagavya	6.02	3.02	0.04	0.02	0.03	0.002	0.001	0.003	0.21	0.23	0.84	0.21
Vermiwash	6.4	2.7	0.02	0.01	0.02	0.001	0.001	0.001	0.13	0.14	0.15	0.02

BDLM, Bio-digested liquid manure; EBDLM, Enriched bio-digested liquid manure

panchagavya might have provided nutrients continuously as well as growth hormones that are linked to the increase in leaf area/plant as a consequence of more assimilatory surface area which promoted production of larger quantities of photosynthates finally resulting in better plant growth and development. More leaves/plant might be owing to the adequate availability and supply of nutrients in balanced proportion, which ultimately resulted in triggering the production of plant growth hormones in combination with humic acid and other hormones in onion. Lal *et al*. (2002) found that with increased rates of organic manure application resulted in better plant growth as indicated by increase in plant height and number of leaves/plant.

Application of EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya at 3% recorded the highest fresh weight of bulb, neck diameter, bulb diameter, bulb length, bulb-size index and bulb yield than all other treatments except T_{10}, T_{11} and T_{13} (Table 3). Application of BDLM at 75 kg N eq./ha recorded the minimum values for all these characters. This might be due to larger availability of nutrients which in turn promoted the growth as well as yield components. Further, the possible reason might have the availability of optimum quantity of major and micronutrients and the action of growth hormones produced by the different sources of organic manures (Muthuramalingam *et al*., 2001; Prabhakaran, 2002). Higher yield of onion was mediated by increased biological process and soil enzymatic activity. Foliar spray of panchagavya and vermiwash might be supplied growth hormones, viz. gibberellic acid, auxin and other growth promoting hormones. Application of panchagavya increased the bulb size, as it contained metabolites required in the source and there was greater accumulation of assimilates in the sink (Velu, 2002).

The quality attributes such as ascorbic acid, total soluble solid, reducing sugar, non-reducing sugars and total sugar were also recorded (Table 3). Application of EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya at 3% recorded highest ascorbic acid (26.1 mg/100 g) content than all other treatments except treatments T_{10}, T_{11}, T_{13} T_6 and T_5 (Table 2). Application of BDLM at 75 kg N eq./ha recorded the lowest ascorbic acid (20.3 mg/100 g). Application of EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya at 3% recorded highest total soluble solid, reducing sugar, non-reducing sugar and total sugars than all other treatments except T_{10}, T_{11} and $T_{13.}$ It might be due to adequate supply of nutrients through EBDLM and plant growth-regulatory substances through panchagavya, which might have improved the quality of onion bulbs. Application of EBDLM and panchagavya, vis-à-vis crop requirement enhanced the supply of plant hormones for improving the quality of onion. Krishnamurthy and Sharanappa (2005) reported improved quality parameters of rose onion bulbs through different source of organic nutrient application. Application of BDLM at 75 kg N eq./ha recorded the minimum values for all these characters.

Table 2. Growth parameters of onion as influenced by various organic sources of nutrients (pooled mean of 2 seasons)

Treatment	Plant height (cm)	Leaves/ plant	Leaf diameter (cm)	Leaf-area index	Total dry-matter accumulation (g/plant)
$T_{1,}$ BDLM at 75 kg N eq./ha	24.8	4.1	0.93	2.13	3.60
$T_{2,}$ BDLM at 75 kg N eq./ha + 3 sprays of vermiwash (3%)	25.1	4.5	0.96	2.22	3.72
$T_{3,}$ BDLM at 75 kg N eq./ha + 3 sprays of panchagavya (3%)	25.9	4.7	0.98	2.30	3.79
$T_{4,}$ BDLM at 100 kg N eq./ha	35.3	6.6	1.28	3.44	6.05
$T_{5,}$ BDLM at 100 kg N eq./ha + 3 sprays of vermiwash (3%)	35.7	6.7	1.28	3.49	6.12
$T_{6,}$ BDLM at 100 kg N eq./ha + 3 sprays of panchagavya (3%)	36.4	6.7	1.30	3.57	6.22
$T_{7,}$ EBDLM at 75 kg N eq./ha	29.7	5.6	1.12	2.73	4.82
$T_{8,}$ EBDLM at 75 kg N eq./ha + 3 sprays of vermiwash (3%)	30.5	5.6	1.13	2.79	4.91
$T_{9,}$ EBDLM at 75 kg N eq./ha + 3 sprays of panchagavya (3%)	31.4	5.7	1.14	2.90	5.01
$T_{10,}$ EBDLM at 100 kg N eq./ha	40.4	7.7	1.43	4.00	7.24
$T_{11,}$ EBDLM at 100 kg N eq./ha + 3 sprays of vermiwash (3%)	41.4	7.9	1.45	4.18	7.43
$T_{12,}$ EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya (3%)	42.3	8.1	1.46	4.26	7.59
$T_{13,}$ RDF (30 t FYM + 125:50:75 kg N: P_2O_5:K_2O/ha)	40.8	7.8	1.44	4.08	7.30
SEm±	1.3	0.3	0.05	0.15	0.29
CD (P=0.05)	3.8	0.9	0.13	0.41	0.81

BDLM, Bio-digested liquid manure (applied at 25, 50 and 75 DAS); DAS, Days after sowing; EBDLM, Enriched bio-digested liquid manure (applied at 25, 50 and 75 DAS); FYM, Farmyard manure; PG, Panchagavya (applied at 30, 60 and 75 DAS); RDF, Recommended dose of fertilizer (applied at 30, 60 and 75 DAS); VW, Vermiwash

Table 3. Yield parameters, bulb yield and quality parameters of onion as influenced by various organic sources of nutrients (pooled mean of 2 seasons)

Treatment	Fresh weight of bulb (g)	Neck diameter (cm)	Bulb diameter (cm)	Bulb length (cm)	Bulb size index (cm^2/ bulb)	Bulb yield (tonnes/ ha)	Ascorbic acid (mg/ 100 g)	TSS (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
T_1, BDLM at 75 kg N eq./ha	93.0	0.84	3.63	3.75	13.61	20.9	20.3	10.5	3.15	7.51	10.66
T_2, BDLM at 75 kg N eq./ha + 3 sprays of vermiwash (3%)	94.6	0.87	3.67	3.82	14.11	22.1	21.0	10.6	3.24	7.58	10.82
T_3, BDLM at 75 kg N eq./ha + 3 sprays of panchagavya (3%)	95.0	0.89	3.69	3.83	14.32	22.6	21.7	10.7	3.28	7.66	10.95
T_4, BDLM at 100 kg N eq./ha	125.8	1.19	5.15	4.78	24.83	34.1	24.1	12.5	3.46	8.07	11.53
T_5, BDLM at 100 kg N eq./ha + 3 sprays of vermiwash (3%)	126.3	1.20	5.17	4.80	24.79	34.8	24.5	12.6	3.57	8.12	11.69
T_6, BDLM at 100 kg N eq./ha + 3 sprays of panchagavya (3%)	126.9	1.22	5.20	4.82	25.26	35.3	24.9	13.5	3.66	8.84	12.51
T_7, EBDLM at 75 kg N eq./ha	109.6	1.03	4.38	4.28	18.79	27.6	22.8	11.0	3.30	7.90	11.20
T_8, EBDLM at 75 kg N eq./ha+ 3 sprays of vermiwash (3%)	111.0	1.04	4.40	4.28	18.89	28.5	23.2	11.1	3.34	7.94	11.28
T_9, EBDLM at 75 kg N eq./ha + 3 sprays of panchagavya (3%)	111.2	1.06	4.43	4.33	19.31	28.9	23.6	11.1	3.36	7.99	11.35
T_{10}, EBDLM at 100 kg N eq./ha	141.4	1.35	5.92	5.27	31.14	40.3	25.1	13.9	3.77	8.90	12.67
T_{11}, EBDLM at 100 kg N eq./ha+ 3 sprays of vermiwash (3%)	142.8	1.38	5.97	5.30	31.61	41.8	25.4	14.2	3.81	8.96	12.78
T_{12}, EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya (3%)	143.7	1.42	6.02	5.36	32.26	42.8	26.1	14.4	3.98	9.05	13.03
T_{13}, RDF (30 t FYM + 125:50:75 kg N: P_2O_5:K_2O/ha)	139.0	1.36	5.92	5.27	31.19	35.9	23.9	13.4	3.61	8.27	12.05
SEm±	5.2	0.04	0.24	0.15	1.48	2.5	0.7	0.6	0.14	0.32	0.35
CD (P=0.05)	14.7	0.12	0.68	0.43	4.20	7.0	1.9	1.7	0.39	0.91	1.00

BDLM, Bio-digested liquid manure (applied at 25, 50 and 75 DAS); DAS, Days after sowing; EBDLM, Enriched bio-digested liquid manure (applied at 25, 50 and 75 DAS); FYM, Farmyard manure; PG, Panchagavya (applied at 30, 60 and 75 DAS); RDF, Recommended dose of fertilizer; VW, Vermiwash

The economics of organic onion cultivation (Table 4) revealed that the highest cost of cultivation, gross returns, net returns and benefit: cost ratio with the application of EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya at 3 % followed by EBDLM at 100 kg N eq./ha + 3 sprays of vermiwash at 3% and EBDLM at 100 kg N eq./ha as compared to the control (Table 4). Because the cost of cultivation in onion due to use of panchagavya, vermiwash and organics were lower, as these manures are cost effective when compared to chemical fertilizers. The organic manurial treatments showed higher benefit: cost ratio, the benefits in terms of quality, nutritional values due to addition of organic manures should not be over looked. Integration of EBDLM or BDLM along with panchagavya and/or vermiwash had a marked effect on increasing the yield of onion and showed the possibility of substituting the synthetic fertilizers effectively by organic manures, which can provide equivalent yield along with improved quality attributes. Jayathilake *et al*. (2003) also reported higher net returns and benefit: cost ratio by organic manure application in lieu of synthetic fertilizer use in onion.

It is clearly evident that organic onion production is feasible by following appropriate scientific organic farming practices with emphasis on organic nutrient supply through locally available manures, green biomass with suitable enrichments

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Table 4. Economics of onion as influenced by various organic sources of nutrients (pooled mean of 2 years)

Treatment	Cost of cultivation (×10³₹/ha)	Gross returns (×10³₹/ha)	Net returns (×10³₹/ha)	Benefit: cost ratio
T_1, BDLM at 75 kg N eq./ha	93.6	231.0	137.4	2.47
T_2, BDLM at 75 kg N eq./ha + 3 sprays of vermiwash (3%)	94.7	243.9	149.3	2.57
T_3, BDLM at 75 kg N eq./ha + 3 sprays of panchagavya (3%)	95.2	249.7	154.5	2.62
T_4, BDLM at 100 kg N eq./ha	103.1	376.0	272.9	3.64
T_5, BDLM at 100 kg N eq./ha + 3 sprays of vermiwash (3%)	103.9	383.8	280.0	3.69
T_6, BDLM at 100 kg N eq./ha + 3 sprays of panchagavya (3%)	104.5	390.4	285.9	3.73
T_7, EBDLM at 75 kg N eq./ha	98.8	305.2	206.3	3.08
T_8, EBDLM at 75 kg N eq./ha+ 3 sprays of vermiwash (3%)	99.7	315.0	215.3	3.16
T_9, EBDLM at 75 kg N eq./ha + 3 sprays of panchagavya (3%)	100.2	318.9	218.8	3.18
T_{10}, EBDLM at 100 kg N eq./ha	108.2	445.0	336.8	4.11
T_{11}, EBDLM at 100 kg N eq./ha+ 3 sprays of vermiwash (3%)	109.5	460.7	351.1	4.20
T_{12}, EBDLM at 100 kg N eq./ha + 3 sprays of panchagavya (3%)	110.4	472.0	361.6	4.27
T_{13}, RDF (30 t FYM +125:50:75 kg N: P_2O_5:K_2O /ha)	102.8	395.2	292.4	3.84

Cost of BDLM ₹0.15/litre; EBDLM ₹0.25/litre; FYM, ₹500/tonne; Vermicompost, ₹5,000/tonne; Panchagavya, ₹300/ha ; Vermiwash, ₹100/ha; Selling price of onion, ₹1,000/quintal for summer onion and ₹1,200/q for *rabi* onion

BDLM, Bio-digested liquid manure (applied at 25, 50 and 75 DAS); DAS, Days after sowing; EBDLM, Enriched bio-digested liquid manure (applied at 25, 50 and 75 DAS); FYM, Farmyard manure; PG, Panchagavya (applied at 30, 60 and 75 DAS); RDF, Recommended dose of fertilizer; VW, Vermiwash

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