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Effect of different Organic Sources of Nutrients on Net Return and Benefit: Cost Ratio of Pomegranate (*Punica granatum* L.) cv. Bhagwa

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ABSTRACT: An experiment was conducted to study the net return and benefit:cost ratio (B:C) of pomegranate (*Punica granatum* L.) 'Bhagwa' as influenced by different organic sources of nutrients. During Mrig bahar (June-January) 2017-18 and 2018-19, the experiment was conducted at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, District-Mehsana in Gujarat, India. The current study used a Randomized Block Design with three replications and twenty-two treatments using four different organic manures as a source of nitrogen, including farm yard manure, vermicompost, poultry manure, and neem cake, as well as recommended doses of manure and fertilizers based on plant age with or without biofertilizers (*Azotobacter*, PSB, and KMB) and biopesticides (*Trichoderma viride* and *Paecilomyces lilacinus*). The results based on pooled data revealed that the maximum net return (4,12,840/ha) and BCR (3.26) recorded by application of 100 % RDN through poultry manure + 50 ml PSB + 25 ml KMB + 5 g *Trichoderma viride* + 5 ml *Paecilomyces lilacinus* compared to other treatments. Thus, the organic sources *viz*., poultry manure with biofertilizers and biopesticides is beneficial for obtaining good economic returns in pomegranate cv. Bhagwa.

Keywords: Pomegranate, organic manure, biopesticides, biofertilizer, net return, benefit:cost ratio (B:C).

INTRODUCTION

Pomegranate (*Punica granatum* L.) is a popular fruit crop in India's dry and semi-arid region because of its hardiness, drought tolerance nature, high productivity and profitability to the growers. Now days, it has a very high export potential. The demand for fresh and processed foods such as juice, wine, syrup, and an acidulant called anardana is steadily increasing (Saxena *et al*., 1984). Pomegranate is a good source of protein, carbohydrate, minerals, antioxidants, vitamin ‘A,’ vitamin ‘B’ and vitamin ‘C’. It is also utilizing in controlling diarrhoea, hyperacidity, tuberculosis, leprosy, chronic stomach ailment and fever. Its fruit rind is rich in tannin. Its barks and rinds are commonly used in dysentery and diarrhoea. The rind is also used as dyeing material for cloth. The seeds are rich in lipid, protein, crude fiber and ash (Singh and Chauhan, 1988). It is also known in Ayurveda as "Dadima" (Paranjpe, 2001) and in the worldwide functional food business as "Super fruit" due to its versatile medical properties (Martins *et al*., 2006). Pomegranate juice is high in antioxidants including soluble polyphenols, tannins, and anthocyanins, and it may have antiatherosclerotic qualities (Michel *et al*., 2005). It can also be used to treat cancer and chronic inflammation (Ephraim and Robert, 2007). Due to its immense utility as medicine, pomegranate fruit is regarded as ‘medicinal miracle’. In the throughout the world but Middle East, America, and Europe having more demand for organically cultivated pomegranate fruits is increasing as people become more health conscious. According to De Candolle, (1967), Pomegranate has been widely cultivated in Mediterranean regions of Asia, Africa, and Europe. It is native to hot, dry areas of Iran, Afghanistan, and neighbouring areas. India is one of the leading producers of pomegranate in world having area over 2.62 lakh ha with annual production 3034 MT. In India, pomegranates are mostly grown on large areas of marginal land with very little organic carbon content. Yields were lost in pomegranate due to less microbial population and deficiency of more than 2–3 plant nutrients (Raghupati and Bhargava, 1998).

Nowadays, indiscriminate use of chemical fertilizers, insecticides and pesticides has resulted in irrecoverable decline of soil physical, chemical and microbiological properties and cause unsustainable productivity in large areas of pomegranate belts. Due to farmers' perception that the productivity can be enhanced only using by such chemical fertilizers and pesticides, the use of such chemicals has reached to the hazardous limits. Pomegranate quality features are severely harmed as a result of indiscriminate application of inorganic agro-chemicals, resulting in quality degradation (as colour, size, shape, flavour, and so on), decreased consumer preference, and low returns to growers. It also causes soil health deterioration and disturbs the soil microorganisms.

In view of this, use of different organic sources of nutrients for pomegranate cultivation, claimed to be the benign alternative for sustainable production, would play a vital role. The role of soil organic matter is well established in improving physico-chemical properties. In sweet orange, soil organic matter is known to improve physico-chemical characteristics (Marathe *et al*., 2009) and regulate nutrient fluxes (Marathe *et al*., 2012), as well as increase microbial biomass (Marathe *et al*., 2010, 2011; Mir *et al*., 2015).

Given the medicinal and nutritional value of pomegranate fruits and plant parts as a whole, as well as the fact that they are economically viable for growers, a more rational approach to sustainable cultivation should be implemented using a variety of locally available organic manures, biofertilizers, and biopesticides to rejuvenate and increase the depleted soil fertility level and increase the available contents of nutrients to the plants, which could benefit the crop. In this background information, the present study, therefore, was focused and planned with the objective to evaluate the influence of different organic sources of nutrients on economics of pomegranate cv. Bhagwa.

MATERIALS AND METHOD

A. Experimental site

The field experiment was conducted at the College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, District: Mehsana, Gujarat during Mrigbahar 2017-18 and 2018-19 on two-year-old uniform pomegranate cv. Bhagwa plants planted at a spacing of 2.5 m × 2.5 m. Jagudan is located at an elevation of 90.6 metres above mean sea level at 23°53' north latitude and 74° 43' east longitude.

B. Experiment setup

The soil of experimental field was well drained and sandy loam with appropriate texture kind**.** The physico-chemical properties of the soil were: pH 7.87, electrical conductivity 0.32 dS m^{-1}, organic carbon 0.49%. The available N, P and K content of surface soil were 243.0kg ha^{-1}, 146.0 kg ha^{-1} and 345.0 kg ha^{-1}, respectively. The pits (0.60 m3) were dug with spacing of 2.5 m × 2.5 m.

C. Experiment design

The experiment was set up in a randomized block design with 22 treatments and three replications, each with two plants. Various treatments were- T_1 – Recommended dose of FYM and NPK applied through chemical fertilizers (Control), T_2 – T_1 + *Trichoderma viride* @ 5 g and *Paecilomyces lilacinus* @ 5 ml per plant, T_3 – 100 % RDN through FYM, T_4 –100 % RDN through vermicompost, T_5 – 100 % RDN through poultry manure, T_6 – 100 % RDN through neem cake, T_7 – 50 % RDN through FYM + 50 % RDN through vermicompost, T_8 – 50 % RDN through FYM + 50 % RDN through poultry manure, T_9 –50 % RDN through FYM + 50 % RDN through neem cake, T_{10} – 50 % RDN through vermicompost + 50 % RDN through poultry manure, T_{11} –50 % RDN through vermicompost + 50 % RDN through neem cake, T_{12} –50 % RDN through poultry manure + 50 % RDN through neem cake, T_{13} –75 % RDN through FYM, T_{14} – 75 % RDN through vermicompost, T_{15} – 75 % RDN through poultry manure, T_{16} – 75 % RDN through neem cake, T_{17} –37.5 % RDN through FYM + 37.5 % RDN through vermicompost, T_{18} –37.5 % RDN through FYM + 37.5 % RDN through poultry manure, T_{19} – 37.5 % RDN through FYM + 37.5 % RDN through neem cake, T_{20} –37.5 % RDN through vermicompost + 37.5 % RDN through poultry manure, T_{21} – 37.5 % RDN through vermicompost + 37.5 % RDN through neem cake and T_{22} – 37.5 % RDN through poultry manure + 37.5 % RDN through neem cake. Biofertilizers (50 ml PSB and 25 ml KMB) along with common dose of *Trichoderma viride* @ 5 g and *Paecilomyces lilacinus* @ 5 ml per plant were applied in the treatment T_3 to T_{22}. In the treatment T_{13} to T_{22}, *Azotobacter* culture was used at 50 ml per plant. For the years 2017-18 and 2018-19, RDN was applied by various organic manures based on plant age as well as treatment, which was calculated based on nitrogen availability. Because the appropriate dose of manure and chemical fertilizers vary from year to year as advised by the National Research Centre on Pomegranate in Table 1, the T_1 and T_2 treatments in the current study were applied according to the age of the pomegranate plant (Sharma *et al*., 2011). Full doses of FYM and half doses of N, P, and K were applied at the target leaf fall stage for both of these treatments.

Table 1: Recommended manure and chemical fertilizer dose/plant/year.

Age of plant (Years)	FYM (kg)	Nitrogen (g)	Phosphorus (g)	Potash (g)
1	10	250	125	125
2	20	250	125	125
3	30	500	125	125
4	40	500	125	250
5 and above	50	625	250	250

Before being applied in the field, the farm yard manure (FYM), vermicompost, chicken manure, and neem cake utilised in this study were evaluated for N, P, and K content (percent) using conventional procedures (Jackson, 1973). In each year of the experiment, 50% nitrogen from RDN was applied in the form of FYM, vermicompost, chicken manure, and neem cake at the optimal leaf fall stage on June 20th, and the remaining dose was applied 60 days following the first split. The application of RDN via various organic sources of nutrients was based on plant age in the treatment T_3 to T_{22} as per treatment.

Table 2: N, P and K content (%) of different organic manures for the year 2017-18 and 2018-19.

Sr. No.	Organic manures	N (%)		P_2O_5 (%)		K_2O (%)	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
1.	FYM	0.65	0.61	0.28	0.26	0.55	0.51
2.	Vermicompost	1.53	1.48	0.45	0.41	0.62	0.59
3.	Poultry manure	2.35	2.44	2.60	2.67	1.98	2.16
4.	Neem cake	5.22	5.15	1.12	1.08	1.50	1.47

To apply organic manures, a ring was formed around the plant canopy with a depth of 20 cm and a width of 15 cm, and manures were uniformly mixed into the ring, which was then levelled. Before application, biofertilizers (*Azotobacter* culture, phosphate solubilizing bacteria, and potash mobilizing bacteria) and biopesticides (*Trichoderma viride* and *Paecilomyces lilacinus*) were well mixed with various organic manures according to treatment. In each year of the experiment, the complete dose of biofertilizers and biopesticide was administered on the 20th of June at the desired leaf fall stage, according to treatment. Each year during the research period, the plants were moderately trimmed during the first week of June. Other cultural activities including weeding and plant protection were performed as needed. Irrigation was started right away.

D. Analysis of economics

The gross realization in term of rupees per hectare was worked out by taking into consideration the prevailing market price of the pomegranate under each treatment during the year 2017-18 and 2018-19.

The cost of cultivation was calculated by taking into account all of the costs associated with cultural operations, from tillage to harvesting, as well as the cost of inputs, for each treatment. After deducting the cost of cultivation from the gross profit, the net profit for each treatment was calculated. The benefit-to-cost ratio (BCR) was calculated using the following formula.

$$\text{BCR} = \frac{\text{Gross realization (₹)}}{\text{Total cost (₹)}}$$

RESULTS AND DISCUSSION

Influence of different organic sources of nutrients on net returns and benefit: cost ratio in pomegranate are presented in Table 3.

Gross realization was multiplying the yield per hectare with the selling price of pomegranate (₹ 30.00 per kg fruit). Maximum net return (₹4,12,840/ha) and BCR (3.26) was found under treatment 100 % RDN through poultry manure + 50 ml PSB + 25 ml KMB + 5 g *Trichoderma viride* + 5 ml *Paecilomyces lilacinus*. Whereas, the minimum net return (` 94,096/ha) was found under treatment 50 % RDN through FYM + 50 % RDN through vermicompost + 50 ml PSB + 25 ml KMB + 5 g *Trichoderma viride*+5 ml *Paecilomyces lilacinus* and minimum BCR (1.32) was found in 75 % RDN through vermicompost + 50 ml *Azotobacter* culture + 50 ml PSB + 25 ml KMB + 5 g *Trichoderma viride*+5 ml *Paecilomyces lilacinus* treatment.

This could be attributed to production of high yield of pomegranate fruits by application of 100 % RDN through poultry manure + 50 ml PSB + 25 ml KMB + 5 g *Trichoderma viride* + 5 ml *Paecilomyces lilacinus* with comparatively moderate cost of cultivation. Whereas, minimum net return and BCR were recorded when pomegranate plant treated with treatment 50 % RDN through FYM + 50 %RDN through vermicompost + 50 ml PSB + 25 ml KMB+ 5 g *Trichoderma viride* + 5 ml *Paecilomyces lilacinus* and treatment 75 % RDN through vermicompost + 50 ml *Azotobacter* culture + 50 ml PSB + 25 ml KMB + 5 g *Trichoderma viride* + 5 ml *Paecilomyces lilacinus*, respectively. This might be the fact that low yield and comparatively higher cost of cultivation of these treatments results in getting minimum net returns and BCR. Application of organic nutrient resources enhanced the net return and benefit cost ratio. The results are in agreement with that of Channabasavanna *et al*. (2020).

Table 3: Influence of different organic sources of nutrients on economics (Pooled basis).

Treatment	Yield per hectare (t)	Gross realization (`/ha)	Total cost of cultivation (`/ha)	Net returns (`/ha)	Benefit: Cost Ratio (BCR)
1	**2**	**3 (2 × ` 30)**	**4**	**5 (3-4)**	**6 (3/4)**
T_1	13.86	415800	152026	263774	2.74
T_2	14.80	444000	155466	288534	2.86
T_3	11.27	338100	204592	133508	1.65
T_4	15.87	476100	348824	127276	1.36
T_5	19.86	595800	182960	412840	3.26
T_6	17.31	519300	235848	283452	2.20
T_7	12.36	370800	276704	94096	1.34
T_8	12.51	375300	193784	181516	1.94
T_9	15.48	464400	220128	244272	2.11
T_{10}	15.75	472500	265904	206596	1.78
T_{11}	14.85	445500	292248	153252	1.52
T_{12}	15.52	465600	209328	256272	2.22
T_{13}	10.58	317400	190112	127288	1.67
T_{14}	13.10	393000	298280	94720	1.32
T_{15}	13.54	406200	173888	232312	2.34
T_{16}	13.09	392700	213504	179196	1.84
T_{17}	12.15	364500	244216	120284	1.49
T_{18}	12.45	373500	181984	191516	2.05
T_{19}	15.57	467100	201848	265252	2.31
T_{20}	13.14	394200	236096	158104	1.67
T_{21}	14.89	446700	255960	190740	1.75
T_{22}	12.92	387600	193728	193872	2.00

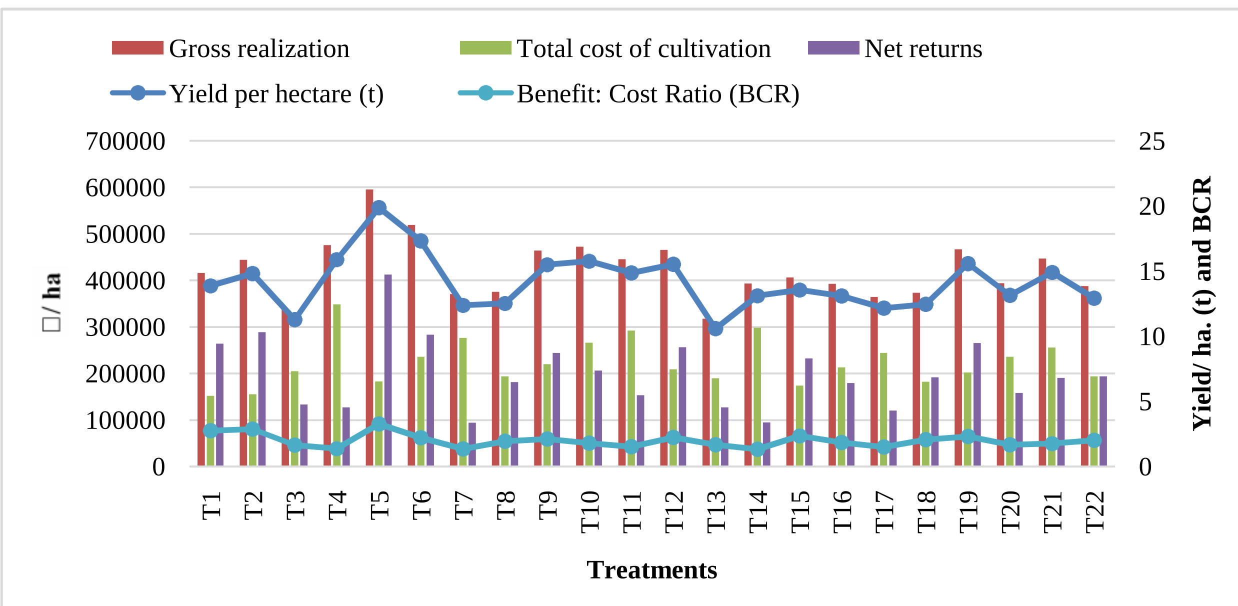

Fig. 1.

CONCLUSION

From the forgoing discussion, it could be concluded on the basis of pooled data that the application of 100 % RDN through poultry manure + 50 ml PSB + 25 ml KMB + 5 g *Trichoderma viride* + 5 ml *Paecilomyces lilacinus* is beneficial for obtaining good economic returns in pomegranate cv. Bhagwa.

FUTURE SCOPE

Fulfillment of global demand of safe and healthy food for the increasing population is currently a crucial challenge. Increasing crop production by preserving environment and reducing adverse climate change should thus be the main aim of today's agriculture. Use of high-yielding varieties, irrigation water, chemical fertilizers and synthetic pesticides are being implemented to increase yields. Due to indiscriminate use of chemical fertilizers or pesticides in many agro-ecosystems, such farming is often responsible for land degradation and environmental pollution and for adversely affecting the health of human beings. Among all inputs required for increased production, nutrients are considered to be the most important source. Use of different organic sources of nutrients may be considered as potential tools for producing safe, healthy and cheaper food restoring soil fertility and mitigating climate change.

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Conflict of Interest. The authors declare that they have no conflict of interest.

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