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Impact of biofertilizers and organic manures on growth, fruit quality and leaf nutrient status of pomegranate in LONI (MS) INDIA

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ABSTRACT

The study was conducted to investigate the effect of organic manures and biofertilizers on the vegetative growth, fruit quality and leaf nutrient status of pomegranate. The treatments consisted of the application of vermicompost, *Azotobacter, Azospirillum*, phosphorous solubilising bacteria (PSB)and farm yard manure (FYM) in different doses and combinations along with a control in which only organic fertilizers were applied. Combined application of vermi compost (15kg/Plant) + Azospirillum@ 150 g/tree + PSB @150 g/tree resulted in maximum plant height, canopy spread, trunk girth, fruit weight, while maintaining yield at par with inorganic fertilizers treatment. Maximum leaf P and K contents were recorded in treatment consisting of vermicompost (15kg/ plant) + *Azospirillum* @ 100 g/tree + PSB @100 g/tree but maximum leaf N content was recorded under FYM (15 kg/ plant) + *Azospirillum* @ 150 g/tree + PSB @150 g/tree. Use of biofertilizers with organic manures was found to be a good approach for production of quality pomegranate fruits without compromising the yield.

Figure : 01 References : 14 Tables : 03
KEY WORDS : Biofertilizers, Pomegranate,Vermicompost

Introduction

Pomegranate (*Punica granatum*)grows extensively over the world's tropical and subtropical zones. For centuries, people have enjoyed pomegranates for their beneficial effects on health. Scientists in the modern day have discovered that pomegranates have health benefits, including a possible ability to stave against cancer. Under the afore mentioned plan, Pomegranate exports have taken place. Although India is the world's second-largest producer of fruits and the global leader in pomegranate production, it only exports a fraction of what it grows. Spain, by contrast, grows 1 million tonnes and ships out 75 thousand tonnes per year. Pomegranate is a high value crop and its whole tree is of considerable economic worth. Fresh fruit and juice are in high demand, but processed goods like wine and sweets are also becoming more significant in international commerce. The state of Maharashtra relies heavily on the export of its pomegranate production. Approximately 85 percent of India's entire pomegranate output comes from this region, which is produced over an area of 43,151 hectares and yields a total of 4,31510tonnes. The regions of Western Maharashtra and the Marathwada are where most of the state's pomegranate crop is grown. Grown in Maharashtra, the Ganesh, Bhagwa (Red Ruby) type is good for export. At the moment, a significant quantity of pomegranates is sent out of the state in refrigerated containers. Disease and pest control according to the prescribed schedules by NRC Pomegranate, Sholapur would improve the financial situation of the impoverished farmers and boost the export of pomegranates from our nation. Multi-nutrient deficits and a decline in soil productivity have been shown in several studies[3]. Additionally, the high cost of inorganic fertilizers alongwith wastage of nutrients caused through leaching, volatilization and denitrification cause severe economic loss to growers. Consequently, there is use of organic manures and biofertilizers, which are safe for humans and environment is gaining the attention of researchers. Biofertilizers, carrier based microbialinoculates containing living microorganisms, are known to increase productivity either by fixing atmospheric nitrogen or solublising phosphorous or producing growth promoting substances in the rhizosphere.

Crop output may be maintained throughout time because of biofertilizers' positive effects on soil's physical, chemical and biological qualities. Crop output may be maintained throughout the time because of biofertilizers' positive effects on soil's physical, chemical, and biological qualities. Biofertilizers are cheaper than inorganic fertilizers, eco-friendly and sustainable as their manufacturing do not require exhaustible energy sources. Under established conventional farming system, organic matter faces adiminishing trend and needs strategy to increase its level in the soil which would facilitate to restore the optimal microbial population in soil[7]. Farm yard manure application at 22 t ha^{-1} resulted in an 18% increase

TABLE-1: Effect of organic manures and biofertilizers on growth parameters of pomegranate

Treatment	Tree height (m)			Stem width (cm)			Tree spread (m)		
	Initial	After harvest	Percentage increase	Initial	After harvest	Percentage increase	Initial	After harvest	Percentage increase
T_1	2.23	2.31	3.76	14.55	20.20	27.01	3.25	3.42	4.97
T_2	1.92	2.05	6.34	19.47	28.17	31.89	3.04	3.20	5.00
T_3	2.07	2.17	4.11	17.67	25.24	29.89	3.18	3.34	4.79
T_4	2.23	2.41	4.08	16.25	30.30	53.63	2.93	3.12	6.08
T_5	2.20	2.25	2.22	19.63	25.83	24.03	2.10	2.24	9.09
T_6	2.53	2.63	3.80	23.87	22.33	37.88	2.35	2.51	6.37
T_7	1.97	2.06	4.68	22.25	30.83	27.83	2.20	2.35	6.38
T_8	1.37	1.50	9.66	15.40	25.00	38.40	2.29	2.47	7.28
T_9	2.13	2.27	6.60	15.40	24.17	36.28	2.43	2.61	6.89
CD at 5%	0.54	0.57		1.83	1.92		0.27	0.28	

in organic carbon content compared with NPK fertilizers in a rice-wheat system over a 34 year period. It is therefore, advantageous that an approach for organic nutrient supply should be developed by using a judicious mixture of biofertilizers and organic sources. ”*Azotobacter, Azospirillum, Glomusfasciculatum, Glomusmosseae*, PSB (phosphorous solubilising bacteria)”. Several types of horticultural crops benefit greatly from the addition of organic manures including farmyard manure and vermicompost[3]. The presence of substances such as humic acid and plant growth hormones in vermicom post, formed by interactions between microorganisms and earthworms,has also been reported as a potential factor contributing to increased plant growth, microbiological processes and yield. Among the biofertilizers are *Azotobacter* (free living) and *Azospirillum*

Associative symbiotic are nitrogen fixing bacteria and can fix about 20-40 kg N/ ha under field conditions and thus capable of substituting upto 50 percent of nitrogen requirement as has been reported in banana[14]. Moreover, the awareness of the consumers for the organic production of fruits is increasing day by day.

With this in mind, we set out to compare the growth, production, and quality of pomegranate Bhagwa when treated with varying concentrations of two types of biofertilizers (nitrogen fixing and phosphorus solubilising) and two types of organic manures (vermicompost and farmyard manure).

Materials and Methods

Four-year-old pomegranate trees were used in this study, which was done in the agricultural year of 2021-22 on a small farm in the Loni, Ahmednagar district of Maharashtra, India. A randomized block design with nine treatments and three replicates was used for the experiment. The several permutations of therapy were as follows:

T_1:”Vermicompost @ 15 kg/Plant + *Azotobacte*r @100 g/tree + phosphorous solubilising bacteria (PSB) @ 100g/tree,

T_2:Vermicompost @ 15 kg/Plant + *Azotobacter*@ 150g/ tree+PSB @150g/tree),

T_3:Vermicompost @ 100 kg/Plant + *Azospirillum*@ 100g/

TABLE-2: Effect of organic manures and biofertilizers on leaf nitrogen, phosphorus and potassium content of pomegranate

Treatment	Nitrogen(%)	Phosphorus (%)	Potassium (%)
T_1	2.18	0.21	0.60
T_2	2.28	0.21	0.73
T_3	2.15	0.24	0.87
T_4	2.52	0.18	0.73
T_5	2.05	0.18	0.60
T_6	2.29	0.21	0.73
T_7	2.14	0.23	0.73
T_8	2.68	0.18	0.73
T_9	2.22	0.16	0.53
CD @ 5%	0.10	0.04	0.17

tree+PSB @150g/tree),

T_4: Vermicompost @ 15 kg/Plant + *Azospirillum*@ 150g/tree+PSB @150g/tree),

T_5: Farmyardmanure(FYM) @ 10kg/Plant+ *Azotobacter*@ 100g/tree+PSB @ 100g/tree),

T_6:FYM@15kg/Plant+*Azotobacter*@ 150g/tree +PSB@150g/tree),

T_7:FYM@ 15kg/Plant+*Azospirillum*@100g/tree +PSB@100g/tree),

T_8:FYM@ 150kg/Plant+*Azospirillum*@ 150g/tree +PSB@ 150g/tree)",

T_9: Recommended dose of inorganic fertilizers (650 g of N, 250 of P_2O_5, 250 g of K_2O).

In the first week of July, the tree basin received its full dosages of FYM, vermicompost and biofertilizers according to the varied treatments. Under the tree canopies, the biofertilizers were spread out evenly and mixed with either FYM or vermicompost, depending on the treatment. The only treatment (T_9) to receive chemical fertilisers at the prescribed amount (650 g of N, 250 of P2O5, 250 g of K2O) was the control. Fertilizers were distributed in the tree basin twice: once in June and once in September. Fertilizers were sprayed at the full bloom stage in the second week of May, using 600 ppm of NAA. After the rainy season crop was controlled in order to get a winter season crop of pomegranate. The plant's development parameters were measured twice, once before and once after the therapy was used. A digital balance was used to record the weight of a sample of 10 fruits harvested while they were in the mature green stage. To determine yield, we multiplied the total quantity of fruit picked from the tree by the typical fruit weight. Total soluble solids, acidity, and total sugars, three key indicators of fruit quality, were measured[1]. Using the 2, 6-dichlorphenol-indophenol dye technique[12], we calculated the ascorbic acid content as a percentage. In December, the third set of fully ripe leaves was harvested for nutritional analysis (at harvest). Dried leaf powder was used for the analysis of total nitrogen (using the micro Kjeldhal technique), phosphorus (using the vanado-molybdo-phosphoric yellow colour method), and potassium after samples were cleaned of any contaminants (by flame photometer method). Using the CPCS1 statistical package, an ANOVA was performed on the data. At the 5% significance level, we analysed the treatment's results.

Results and Discussion

Table-1 shows that the use of organic manures

TABLE-3: Effect of organic manures and biofertilizers on physical parameters of pomegranate fruit and yield per tree

Treatments	Average Fruit weight (g)	Length of fruit (cm)	Breadth of Fruit fruit (cm)	Average fruit yield (kgplant-1)
T_1	216.33	6.27	7.03	27.78
T_2	237.67	7.73	6.53	51.68
T_3	210.00	7.77	7.93	51.19
T_4	262.33	8.20	7.97	66.72
T_5	237.33	7.08	6.07	34.56
T_6	252.00	8.13	6.93	35.19
T_7	292.67	7.83	7.17	47.99
T_8	237.33	7.93	7.23	61.65
T_9	213.33	8.33	7.83	67.87
CD @ 5%	13.2	1.15	1.23	5.48

and biofertilizers had a major impact on the vegetative development of pomegranate. Treatment 2 (Vermicompost @ 15 kg/Plant + *Azotobacter* @ 150 g/tree + PSB @ 150 g/tree) resulted in the greatest increase in tree height (6.34%) and spread (6.08%), while treatment 5 (Farm yard manure @ 10 kg/Plant + *Azotobacter* @ 100 g/tree + PSB @ 100 g/tree) resulted in the least, at 2.51% and 2.40%, respectively. The changes, however, were not statistically significant when compared to the optimal fertiliser dosage (T9). Under FYM (15 kg/plant) + *Azotobacter* @100 g/tree + PSB @100 g/tree (T5), growth was lowest. Maximum tree height, spread, and girth were observed in trees treated with vermicompost, *Azospirillum* @ 150 g/tree, and PSB @ 150 g/tree, may be attributed to the beneficial effect of microbes in the rhizosphere, which promoted greater solute mobilisation to the roots and consequently enhanced tree growth behaviour. One possible explanation for the rise in vegetative growth is that nitrogen-fixing biofertilizers, such as *Azospirillum* and *Azotobacter*, secrete growth-promoting hormones like IAA, are taken up by the roots[8]. Table 2 presents data on leaf nutrient status, shows that after fruit harvest, the treatment consisting of FYM (15 kg/plant) + *Azospirillum* @150 g/plant + PSB @150 g/plant (T8) resulted in the highest leaf nitrogen content (2.68 percent), followed by the treatment consisting of vermicompost (15 Kg/plant) + *Azospirillum* @150 g/plant + PSB @150 g/plant (T4), While FYM (10 kg/plant) + *Azospirillum* @100 g/tree + PSB had the lowest nitrogen content (2.14%),@100 g/ tree (T_7) treatment.

This is an indication of the fact that *Azospirillum* and vermicompost, by virtue of their nutrient-releasing characteristics, boosted vegetative growth. Because of its nitrogen fixing characteristics and its function in greater absorption of water and nutrients, *Azospirillum* contributes to a higher nitrogen content in leaves. Vermicompost (15 kg/Plant) + *Azospirillum* (100 g/tree) + PSB (100 g/tree) (T_3) produced the highest levels of leaf P (0.24 percent), however T_1, T_2, T_6, and T_7 were statistically equivalent. Phosphorus solubilizing microorganisms given *via* the treatments solubilized the fixed P and made it freely accessible to the plant and is likely by applying various combinations of organic manure and biofertilizers increased leaf P content.

The vermicompost (15 kg/plant) + *Azospirillum* @100 g/plant + PSB @100 g/plant (T_3) treatment resulted in the greatest potassium in leaf (0.87 percent) after fruit harvest, and was statistically comparable to the T_2, T_4, T_6, T_7, and T_8 treatments. With a controlled minimum potassium concentration of 0.53 percent (T_9). In fact, microbes are the primary mediators of nutrient mineralization, with 90% of nutrients being mineralized by them and hence accessible in the soil solution and, ultimately, treatments. in plants. Similar results on the impact of organic food sources on pomegranate leaf nutrient content were reported earlier[10].

Physical parameters of pomegranate fruits

Perusal of data presented in Table 3 with respect to physical parameters shows that there was significant variation due to various combinations of biofertilizers and manures. Data revealed that the maximum fruit weight (262.33 g), fruit breadth (7.97 cm) was obtained in the treatment Vermicom post @ 15 kg/Plant + *Azospirillum* @150g/ tree+PSB@150g/ tree(T_4). This was closely followed by treatment T_9 in which trees received full dose of inorganic fertilizers and average fruit weight was recorded to be 213.33g. Also the fruit length (8.33cm) was the highest in this treatment.Vermicompost (15 kg/ plant) + Azotobacter @100 g/tree + PSB @100 g/tree (T_1) yielded the shortest fruits, measuring in at 6.27 centimetres. Increases in both the length and width of the fruit led to a similar rise in the average weight of each individual fruit. The solubilizing action of biofertilizers (PSB) on fixed forms of nutrients in soil, as well as the direct supply of accessible nutrients to the trees from vermicompost following adequate decomposition and mineralization, may account for the positive effect of these treatments on pomegranate fruit size.

As a result of the release or synthesis of growth hormones, these organic food sources are known to hasten the movement of photosynthates from source to sink, which likely aided in the promotion of rise in fruit size. It was found that using organic manures in combination with biofertilizers improved fruit development metrics more than using organic manures alone[5]. Maintaining pomegranate output was easier with the addition of biofertilizers and vermicompost than with inorganic fertilizers, and a slightly larger dosage of biofertilizers, that is, 150 g per tree as opposed to 100 g per tree, was more successful when applied with organic manure. According to the results (Table-3) the highest fruit output (67.87 kg per plant) was achieved by using inorganic fertilizers.

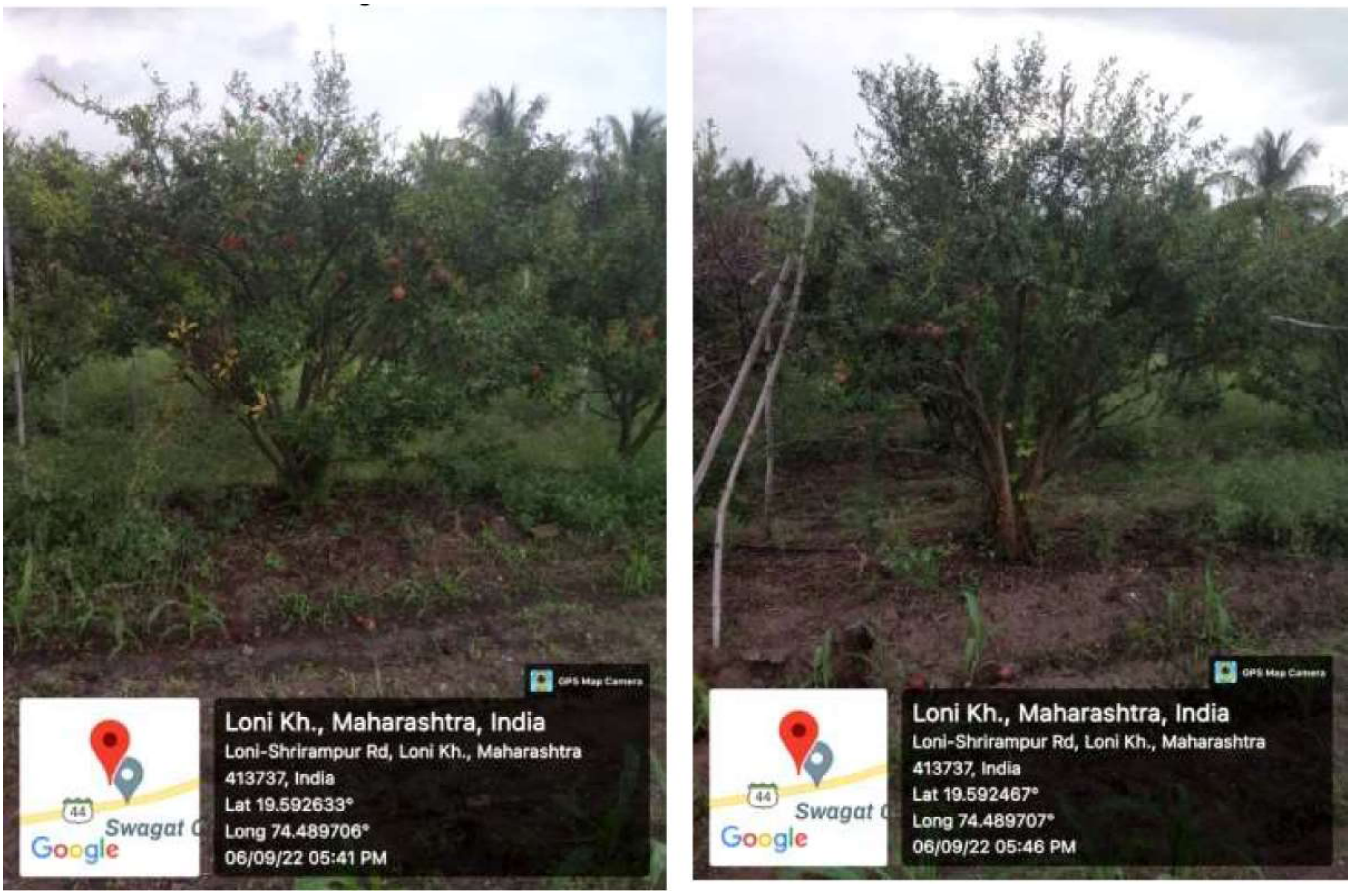

Fig. 1: Effect of organic manures and biofertilizers on Pomegranate tree (before and after treatment)

Comparing the results with those obtained with Vermicompost at 15 kg/Plant + *Azospirillum* at 150 g/ tree + PSB at 150 g/tree, there was no statistically significant difference (T_4). When *Azosprillium* was included in the mix, the yield increase was much higher than with any of the other components. It is possible that increased P availability from PSB and improved nitrogen fixation by *Azospirillum* in the rhizosphere are responsible for the increased plant growth and yield seen in response to a dual inoculum including both organisms. These results are consistent with those found earlier[6] that only applying biofertilizers and organic manure improved pomegranate's physical qualities.

Evidence from measurements of leaf nutrient status suggests that the higher fruit quality may be attributable to the fact that the use of these microbial fertilisers boosted nutrient availability and improved plants' capacity for greater solute absorption from the rhizosphere. Organic manures and biofertilizers are also a good source of micronutrients, which are essential throughout a plant's reproductive period. The microorganisms in biofertilizers may also have contributed to the higher quality of the fruit by producing plant growth regulators, vitamins, and amino acid content. As a result, the pomegranate trees that were fed both to inorganic and biofertilizers yielded fruit of a higher grade.

Present studies suggest that the biofertilizers can be used to obtain quality pomegranate fruits without compromising the yield. Since combination of nitrogen fixing bacteria and PSB with organic manures significantly increased the growth, quality and leaf nutrient content of pomegranate.Thus, it was determined that *Azospirillum,* PSB, and vermicompost are an effective combination for growing high-quality pomegranate fruit.

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