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Effect of organic and inorganic fertilizers on growth and economics of treatments of pomegranate (*Punica granatum* L.) under precision farming

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Abstract
The current study examined how organic and inorganic fertilizers affected the growth and economics of treating pomegranate (*Punica granatum* L.) trees under precision farming in the 2020–2021 growing season on two to three-year-old pomegranate trees of the cv. Super Bhagwa variety at the PFDC (Precision Farming Development Centre), Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur. Ten treatments with three replications were used in the experiment, which was set up using a Randomized Block Design. The findings show that both organic and inorganic fertilizers had a substantial impact on the growth parameters of pomegranate plants, including plant height, average shoot length, number of shoots per plant, benefit cost ratio, net return, and gross return per hectare. According to the findings, the greatest growth parameter.

Keywords: Cowurine, vermiwash, organic fertilizer, inorganic fertilizer and pomegranate

Introduction
The pomegranate (*Punica granatum* L.), a member of the family Punicaceae and genus Punica, is a significant fruit crop of the Tropical and Subtropical areas. Pomegranates are grown for their delightful, energising flavour that is sweet and acidic in nature. Pomegranate juice, beverages, wine, syrup, and jelly are all made from the fruit. Pomegranate is also used to create "Anardana" (Singh and Singh, 2004) [11].

Pomegranates are a tidy, rounded shrub or small tree that can reach heights of up to 20 or 30 feet, though they normally reach between 12 and 16 feet. Although it is often deciduous, in some places the tree will keep its leaves all year. An initially reddish-brown bark that subsequently turns grey covers the trunk. The branches are angular, brittle, and frequently spiky. After roughly 15 years, a pomegranate's vigour starts to wane. The leaves are lance-shaped, lustrous, and slender. At the ends of the branches, the flowers can be seen either alone or in groups of two or three. Insects both cross-pollinate and self-pollinate the pomegranate. Fruit set is increased by cross-pollination (Kumari *et al*., 2012) [6].

Pomegranates are a staple food in semi-arid and rain-fed regions. Even marginal degraded land that was once deemed unsuitable for crop growth can now be cultivated. In addition, this crop was transformed into a resilient fruit crop due to its ability to tolerate some saline in the soil and water.

Iranians are the original cultivators of the pomegranate, which is also widely grown in other Mediterranean nations like Spain, Morocco, Egypt, Afghanistan, and Baluchistan. In some capacity, it is also grown in Burma, China, Japan, the United States (California), and India. According to NHB (Anonymous, 2017) [1], India has 192 thousand hectares of pomegranate agriculture, with a production of about 2263 thousand MT.

The fruit of the pomegranate, known as the aril, is the component that can be eaten. Moisture (78.0%), Calcium (10 mg), Protein (1.6%), Phosphorus (70 mg), Fat (0.1%), Iron (0.3 mg), Minerals (0.7%), Vitamin C (16 mg), Carbohydrates (14.5%), Small amount of Vitamin B Complex, Fibre (5.1%), and Calorific Value (65) are all present in good amounts in the fruit's components, (Bhowmik *et al*., 2013) [2].

Materials and Methods
In the year 2020 - 2021, the experiment was carried out in the PFDC at the Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur. On a two to three year old pomegranate tree of the variety Super Bhagwa, the experiment was carried

out using a Randomised Block Design with ten treatments and three replications. Ninety trees in experimental plant, spaced 2 metres apart, were a part of the experiment.

Application of fertilizer dosages in October for T_0 soil application, nitrogen, phosphorus, and potassium were added using urea, di-ammonium phosphate, and muriate of potash, respectively. 250 g N, 100 g P_2O_5, and 250 g K_2O per plant were the recommended doses for N, P_2O_5, and K_2O, respectively. Half of the urea was administered at the soil application, together with the full doses of D.A.P. and M.O.P. The remaining half of the urea was applied during the fruit setting stage. The recommended amounts of N, P_2O_5, and K_2O employed were 250 g N, 100 g P_2O_5 and 250 g K_2O per plant, respectively, and other inorganic fertilizer in combined treatment be used. The fertilizers for the treatments T1 to T9 were applied via water soluble fertilizer (19: 19: 19). Statistical analysis was done by using method of analysis of variance (ANOVA) for randomized block design (RBD) by Fischer and Yates (1963) [3].

Treatment combinations

T_0 (Control) 100% of RDF as soil application and irrigation through drip
T_1 60% of RDF through drip
T_2 80% of RDF through drip
T_3 100% of RDF through drip
T_4 60% of RDF + Vermiwash through drip (1 litre/ week)
T_5 80% of RDF + Vermiwash through drip (1 litre/ week)
T_6 60% of RDF + Cow urine through drip (1 litre/ week)
T_7 80% of RDF + Cow urine through drip (1 litre/ week)
T_8 60% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)
T_9 80% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)

Result

Effect of organic and inorganic fertilizers on plant height (m) of pomegranate significantly influenced the plant height at 30 days after fertigation, plant height ranged from 1.31 m to 1.65 m. The maximum plant height was recorded under treatment T_9 (1.65 m) followed by T_8 (1.58), T_7 (1.55), T_6 (1.49), T_5 (1.41), T_1 (1.39), T_3 (1.37), T_2 (1.33), T_4 (1.32) and T_0 (1.31) m, respectively. At 60 days after fertigation, plant height ranged from 1.47 to 2.11 m. The maximum plant height was recorded under treatment T_9 (2.11 m) followed by T_8 (2.04), T_7 (1.94), T_6 (1.71), T_5 (1.63), T_4 (1.60), T_1 (1.59), T_2 and T_3 (1.58) and T_0 (1.47) m, respectively. At 90 days after fertigation, plant height ranged from 1.73 to 2.41 m. The maximum plant height was recorded under treatment T_9 (2.41 m) followed by T_8 (2.18), T_7 (2.29), T_6 (1.99), T_5 (1.89), T_3 (1.81), T_1 (1.80), T_2 (1.79), T_4 (1.78) and T_0 (1.73) m, respectively. At 120 days after fertigation, plant height ranged from 1.91 to 2.72 m. The maximum plant height was recorded under treatment T_9 (2.72 m) followed by T_8 and T_7 (2.47), T_6 (2.31), T_4 (2.17), T_5 (2.11), T_3 (2.09), T_2 (1.98), T_1 (1.93) and T_0 (1.91) m, respectively. At 150 days after fertigation, plant height ranged from 2.10 to 2.96 m. The maximum plant height was recorded under treatment T_9 (2.96 m) followed by T_8 (2.78), T_7 (2.64), T_6 (2.53), T_4 (2.45), T_5 (2.39), T_3 (2.30), T_2 (2.29), T_1 (2.18) and T_0 (2.10) m, respectively. Similar results were found by Abdel-sattar and Mohamed (2017) [9]. This result is in close conformity with the earlier finding by Kurer *et al.* (2017) [7] the effectiveness of organics on pomegranate (*Punica granatum* L.) cv. growth behaviour and fruit yield was examined through an experiment, Super Bhagwa in Karnataka's northern arid zone. Using the results as a guide, it can be said that increasing the growth (3.00 m) and yield of pomegranate cv by 100% RDN using vermicompost and 100% RDN through chicken manure, respectively, was the best performance. Bhagwa Super.

It is evident from the table that the effect of organic and inorganic fertilizers on average shoot length (cm) of pomegranate significantly influenced the plant average shoot length at 30 days after fertigation, average shoot length ranged from 23.85 to 33.10 cm. The maximum average shoot length was recorded under treatment T_9 (33.10 cm) followed by T_8 (31.72), T_7 (29.82), T_6 (29.42), T_5 (28.11), T_4 (27.21), T_3 (27.08), T_2 (26.05), T_1 (25.75) and T_0 (23.85) cm, respectively. At 60 days after fertigation, plant average shoot length ranged from 42.23 to 68.27cm. The maximum plant Average shoot length was recorded under treatment T_9 (68.27 cm) followed by T_8. (65.73), T_7 (63.21), T_6 (54.63), T_5 (50.10), T_4 (46.25), T_3 (45.08), T_2 (43.87), T_1 (43.33) and T_0 (42.23) cm, respectively. At 90 days after fertigation, average shoot length ranged from 57.62 cm to 80.77cm. The maximum plant average shoot length was recorded under treatment T_9 (80.77 cm) followed by T_8 (79.86), T_7 (78.59), T_6 (68.13), T_5 (65.09), T_3 (60.26), T_1 (60.16), T_4 (59.33), T_2 (58.91) and T_0 (57.62) cm, respectively. At 120 days after fertigation, average shoot length ranged from 65.81 to 86.25 cm. The maximum plant average shoot length was recorded under treatment T_9 (86.25 cm) followed by T_8 (86.13), T_7 (83.90), T_6 (80.65), T_3 (74.23), T_5 (72.27), T_2 (68.80), T_4 (68.49), T_1 (67.89) and T_0 (65.81) cm, respectively. At 150 days after fertigation, average shoot length ranged from 70.37 to 95.98 cm. The maximum plant average shoot length was recorded under treatment T_9 (95.98 cm) followed by T_8 (92.22), T_7 (89.77), T_6 (86.38), T_4 (78.83), T_5 (77.59), T_3 (77.32), T_2 (76.13), T_1 (74.93) and T_0 (70.37) cm, respectively. Similar results were found by Kurer *et al.* (2017) [7] were result is in close conformity with the earlier finding average shoot length ranged 82.30 to 95.30, Abdel-sattar and Mohamed (2017) [9].

It is evident from the table that the effect of organic and inorganic fertilizers on number of shoot / plant of pomegranate significantly influenced the No. of shoot/ plant at 30 days after fertigation, No. of shoot / plant ranged from 9.33 to 17.33. The maximum No. of shoot was recorded under treatment T_9 (17.33) followed by T_8 (16.66), T_7 (16.33), T_6 (15.66), T_5 (15.33), T_4 (15.00), T_3 (14.33), T_2 (13.33), T_1 (11.66) and T_0 (9.33), respectively. At 60 days after fertigation, No. of shoot / plant ranged from 16.66 to 24.33. The maximum No. of shoot was recorded under treatment T_9 (24.33) followed by T_8 (22.66), T_7 (21.00), T_6 (19.66), T_3 (19.33), T_5 (19.00), T_4 (18.66), T_2 (18.33), T_1 (17.66) and T_0 (16.66), respectively. At 90 days after fertigation, No. of shoot / plant ranged from 19.00 to 31.00. The maximum No. of shoot was recorded under treatment T_9 (31.00) followed by T_8 (29.00), T_5 (24.33), T_6 (23.33), T_7, T_4 and T_1 (22.66), T_2 (22.33), T_3 (21.00) and T_0 (19.00), respectively. At 120 days after fertigation, No. of shoot / plant ranged from 27.66 to 34.00. The maximum No. of shoot was recorded under treatment T_9 (34.00) followed by T_8 (32.66), T_7 (31.66), T_6 (30.33), T_3 (29.00), T_4 (29.33), T_5 (29.33), T_2 (28.66), T_1 (28.33) and T_0 (27.66), respectively. At 150 days after fertigation, No. of shoot / plant ranged from 29.66 to 38.33.

The maximum No. of shoot was recorded under treatment T_9 (38.33) followed by T_8 (36.66), T_7 (34.33), T_6 (34.00), T_5 (33.66), T_4 (33.00), T_3 (33), T_2 (30.66), T_1 (30.00) and T_0 (29.66), respectively. Similar results were found by Kurer *et al.* (2017) [7] and Jadhav, *et al*., 2018 [5] were result is in close conformity with the earlier finding average shoot length ranged 34.30 to 39.93.

Table 1: Effects of organic and inorganic fertilizers on plant height (m) of pomegranate

Notation	Treatments	30 days	60 days	90 days	120 days	150 days
T_0	100% of RDF as soil application and irrigation through drip (Control)	1.31	1.47	1.73	1.91	2.10
T_1	60% of RDF through drip	1.39	1.59	1.80	1.93	2.18
T_2	80% of RDF through drip	1.33	1.58	1.79	1.98	2.29
T_3	100% of RDF through drip	1.37	1.58	1.81	2.09	2.30
T_4	60% of RDF + Vermiwash through drip (1 litre/ week)	1.32	1.60	1.78	2.17	2.45
T_5	80% of RDF + Vermiwash through drip (1 litre/ week)	1.41	1.63	1.89	2.11	2.39
T_6	60% of RDF + Cow urine through drip (1 litre/ week)	1.49	1.71	1.99	2.31	2.53
T_7	80% of RDF + Cow urine through drip (1 litre/ week)	1.55	1.94	2.18	2.47	2.64
T_8	60% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)	1.58	2.04	2.29	2.47	2.78
T_9	80% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)	1.65	2.11	2.41	2.72	2.96
S.Em±		0.07	0.01	0.009	0.01	0.007
CD at 5% level		0.21	0.04	0.02	0.03	0.02

Table 2: Effects of organic and inorganic fertilizers on average shoot length (cm) of pomegranate

Notation	Treatments	30 days	60 days	90 days	120 days	150 days
T_0	100% of RDF as soil application and irrigation through drip (Control)	23.85	42.23	57.62	65.81	70.37
T_1	60% of RDF through drip	25.75	43.33	60.16	67.89	74.93
T_2	80% of RDF through drip	26.05	43.87	58.91	68.80	76.13
T_3	100% of RDF through drip	27.08	45.08	60.26	74.23	77.32
T_4	60% of RDF + Vermiwash through drip (1 litre/ week)	27.21	46.25	59.33	68.49	78.83
T_5	80% of RDF + Vermiwash through drip (1 litre/ week)	28.11	50.10	65.09	72.27	77.59
T_6	60% of RDF + Cow urine through drip (1 litre/ week)	29.42	54.63	68.13	80.65	86.23
T_7	80% of RDF + Cow urine through drip (1 litre/ week)	29.82	63.21	78.59	83.90	89.77
T_8	60% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)	31.72	65.73	79.86	86.13	92.22
T_9	80% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)	33.10	68.27	80.77	86.25	95.98
S.Em±		0.18	0.14	0.41	0.30	0.40
CD at 5% level		0.53	0.44	0.85	0.62	0.83

Table 3: Effects of organic and inorganic fertilizers on No. of shoot /plant

Notation	Treatments	30 days	60 days	90 days	120 days	150 days
T_0	100% of RDF as soil application and irrigation through drip (Control)	9.33	16.66	19.00	27.66	29.66
T_1	60% of RDF through drip	11.66	17.66	22.66	28.33	30.00
T_2	80% of RDF through drip	13.33	18.33	22.33	28.66	30.66
T_3	100% of RDF through drip	14.33	19.33	21.00	29.66	33.00
T_4	60% of RDF + Vermiwash through drip (1 litre/ week)	15.00	18.66	22.66	29.33	33.33
T_5	80% of RDF + Vermiwash through drip (1 litre/ week)	15.33	19.00	24.33	29.00	33.66
T_6	60% of RDF + Cow urine through drip (1 litre/ week)	15.66	19.66	23.33	30.33	34.00
T_7	80% of RDF + Cow urine through drip (1 litre/ week)	16.33	21.00	22.66	31.66	34.33
T_8	60% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)	16.66	22.66	29.00	32.66	36.66
T_9	80% of RDF + Vermiwash + Cow urine through drip (1 litre/ week)	17.33	24.33	31.00	34.00	38.33
S.Em±		1.87	1.86	1.89	1.87	1.85
CD at 5% level		5.52	5.51	5.57	5.51	5.47

A crop's net revenue and benefit: cost ratio have a role in whether or not farmers choose to use it for commercial production. Therefore, it's crucial to determine the financial advantage by calculating the increase in pomegranate production by using each treatment combination.

Benefit cost ratio presented in table and graphically Although T9 (80% RDF + Vermiwash + cow urine through drip (1 litre / week) provided highest net return (316840 Rs./ha), highest gross return (430000 Rs./ ha), highest yield and highest benefit: cost ratio (3.79) was found under treatment T9 (80% RDF + Vermiwash + cow urine through drip (1 litre / week). Similar results were found by Shanmugasundaram and Balakrishnamurthy (2015) [10], Sudhakr, *et al*., (2015) [12] the highest benefit: cost ratio (3.2) was found under treatment T2 (50% of RDF through fertigation).

Table 4: Effects of organic and inorganic fertilizers on economics of treatments

Notation	Cultivation cost ha^{-1}	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B: C ratio
T0	97860	290000	192140	2.96
T1	104460	320000	215540	3.06
T2	107660	366000	258340	3.39
T3	110860	380000	269140	3.42
T4	107460	390000	282540	3.62
T5	110660	400000	289340	3.61
T6	106960	380000	273040	3.55
T7	110160	400000	289840	3.63
T8	109960	410000	300040	3.72
T9	113160	430000	316840	3.79

Conclusion

According to the findings of the current study, only organic sources could satisfy the nutritional needs of pomegranates without compromising yield characteristics. Organic and inorganic fertiliser treatments T_9 - 80% of RDF + Vermiwash + Cow urine by drip (1 litre/week) were found to have a better impact on growth parameters. The more fertilizer applied by the use of water soluble fertilizer, Vermiwash, and cowurine - 80% of the recommended dose the better it was discovered to be to boost the growth parameters of pomegranate plants, including plant height, average shoot length and number of shoots per plant. Based on the results of the current study on the impact of different organic and inorganic treatment combinations on the economics of pomegranates, it can be that the best results are obtained when benefit cost ratio and gross revenue are highest in concluded under treatment T_9 80% of RDF + Vermiwash + Cow urine through drip (1 litre/ week).

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