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Effect of INM to Improve availability of Leaf Nutrients in Pomegranate

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ABSTRACT: A field experiment was carried out during the years 2020-21 and 2021-22 in the experimental orchard of CCSHAU, Hisar to study the effect of farmyard manure and biofertilizers with RDF on leaf nutrient content of pomegranate cv. Bhagwa. Twenty two treatments were arranged in a randomized complete block design with three replicates. The main challenge of plant nutrient may be to increase the width of the domain between the access and excess frontiers rather than to define a single economic optimum point. The leaf analysis offers the most accurate and reliable diagnostic tool for examining the nutritional status of trees. Results revealed different fertilizer combination significantly enhanced leaf nitrogen, phosphorus, potassium content due to farmyard manure and biofertilizers application. Also, farmyard manure and biofertilizers could compensate for the 25% reduction of chemical fertilizers, Therefore, treatment T14-RDF 75% + FYM + *Azotobacter* + PSB is recommended for growers. This treatment gave best result by increasing the nutritional status of the plant through the beneficial effects of organic and biofertilizers which enhanced the availability of nutrients in the soil.

Keywords: RDF, FYM, pomegranate, biofertilizer.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is a member of the monogeneric Punicaceae family and native of Iran and having a chromosomal number 2n=16 (Rana *et al.*, 2010). It is derived from the Latin name of the fruit, *Malum granatum*, which means "grainy apple". It is also commercially cultivated in countries like India, Morocco, Spain, Egypt, Afghanistan, Myanmar, Baluchistan, Japan, China, USA and Central Asia. India is the world's largest producer of pomegranates. It has a very high export potential owing to its antioxidant and nutraceutical values (Newman and Lansky 2007). Each and every part of pomegranate plant posses pharmaceutical and therapeutic properties hence it is cited as “Power house of health or Super fruit” (Sharma and Maity 2010). The total area under pomegranates in India is 2.88 lakh hectares, and the total production is 32.71 lakh tons with a productivity of 11.40 tonnes per hectare. Pomegranate production is very low in Haryana, with an area of just 0.04 thousand hectares (Anon., 2021). The pomegranate has become a popular fruit in tropical and subtropical regions due to increased demand and high export potential (Koujalagi *et al.*, 2014). It occupy second largest area among arid fruits after ber (Sutanu *et al.*, 2017). Bhagwa, Dholka, Kabul, Alandi, G-137, Ganesh, Khandari, Mridula and Jyoti are important cultivars grown in India (Wasker and Sushanta 2004). The plant is drought resilient, cold hardy and thrives well in wet circumstances. It is a shrub with a bushy look that naturally has many trunks. It is used in controlling diarrhea, hyperacidity, tuberculosis, leprosy, abdominal pain and fever. Due to its multipurpose medicinal uses it is also known as “Dadima” in Ayurveda (Prakash Paranjpe 2001) Its juice is high in antioxidants like soluble polyphenols, tannins and anthocyanin and it has anti-atherosclerotic capabilities (Michel *et al*., 2005). Flowering habit of pomegranate is influenced by the prevailing climate condition of the geographical region where it is grown. Review of literature relevant to pomegranate and other fruit crops on effect of integrated nutrient management in leaf nutrient is presented as: Dutta *et al.* (2010) conducted a trial to study the effect of biofertilizers and organic manures with or without chemical fertilizers combination on litchi and recorded maximum leaf N and K with the combined application of 100 g VAM + 50 kg FYM +150 g *Azotobacter* + 500 g N : 250 g P_2O_5 : 500 g K_2O /tree/year. An experiment was conducted by Sharma *et al.* (2013) to investigate the effect of organic manures and biofertilizers in guava *cv.* Sardar with the application of full dose of nitrogen to the plant applied through poultry manure augmented with *Azotobacter* and *Azospirillium* and they recorded that pooled analysis of two year data have maximum leaf nitrogen (1.73%), potassium (1.23%), phosphorus (0.24%), magnesium (0.80%) & calcium (1.96%), and maximum fruit nitrogen (1.12%), potassium (0.94%), phosphorus (0.15%), magnesium (0.66%) & calcium (0.22%) content after fruit harvest.

Vanilarasu and Balakrishnamurthy (2014) conducted an experiment to study the influence of organic manures & amendments and green manures on leaf nutrient status of banana *cv.* Grand Naine. The maximum nutrient status of N, P and K in leaves of treated plants was observed after 5 to 7 months of planting due to the highest uptake of nutrient.

Das *et al.* (2015) conducted an experiment on organic fruit production of guava *cv.* L-49 and recorded maximum nitrogen (1.48 %) and potassium (1.11 %) in leaf with the combined application of FYM @ 20 Kg per plant + Vermicompost @ 5 Kg per plant while maximum leaf P (0.40 %) was observed with the application of Vermicompost @ 10 Kg per plant + FYM @ 20 kg/plant. Aseri *et al.* (2008) concluded that the dual inoculation with *Glomus mosseae* and *Azotobacter chroococcum* recorded maximum leaf micronutrients and N, P, K, Ca, Mg in pomegranate seedlings. Ram and Rajput (2000) found that an increase in nitrogen, magnesium and calcium content of leaf and calcium, potassium and nitrogen content of fruit in Chandler cultivar of strawberry through the inoculation of nitrogen fixing bacteria *Azotobacter*. Kundu *et al.* (2015) observed that sole use of vermicompost or neem cake was found to be effective in improving the ber leaf phosphorus content as compared to other treatments. FYM or vermicompost and their combination *i.e.* ½ (FYM + Vermicompost) resulted higher leaf nitrogen and potassium content. Khachi *et al.* (2015) studied the comparative efficacy of bio-organic nutrients on cropping behavior and fruit quality of kiwifruit and found among various treatments the combination of FYM at 15 kg/vine, GM, VC at 15kg/vine, BF at 50-g/vine and VW at 2kg/vine significantly improved cropping behavior. This superior combination also resulted in considerably greater amounts of leaf macro-and micronutrients: N(2.49%), P(0.26%), K(1.48%), iron (Fe:208.0mg/kg), copper (Cu:17.8mg/kg), zinc(Zn: 36.2 mg/kg), and manganese (Mn: 88.3 mg/kg), which might be responsible for better cropping behavior, productivity and nutrient profile for sustain able kiwi fruit production. Mamta *et al.* (2017) reported that inoculation of *Azoto* 3 + PSB + 75% NP + 100% Kat 120 days after transplanting resulted into increase in nitrogen uptake by papaya by 25.62 at control to 43.76 mg per seedling. Verma and Chauhan (2013) studied the effect of integrated nutrient application onapple productivity and soil fertility in temperate zone of Himachal Pradesh was investigated. Leaf nutrient content *viz.*, nitrogen, phosphorus and potassium were significantly affected by organic manures, bio-fertilizer and inorganic fertilizers treatments during both the years of experimentation. Maximum values of leaf nutrient contents were recorded under T_5 (IFFCO mixture + Urea + MOP + lime + FYM) treatment followed by T_1 (recommended doses) treatment and minimum values were recorded under control (T_6-without fertilizers, manures and biofertilizers) treatment. Belhekar and Bhosale (2010) found maximum amount of chlorophyll content (0.020 and 0.022 mg/g) in fresh leaves of onion treated with AZT-8, followed by AZT-2(0.019 and 0.020 mg/g) at 15 and 30 days after sowing, respectively. Rathore (2008) reported in litchi cv. Rose scented that *Azotobacter* was responsible for the maximum nitrogen and K in leaf while 500: 250: 250 g NPK/tree + 50 kg FYM enriched with VAM caused maximum P in leaf.

MATERIALS AND METHODS

The experiment was conducted at the experimental orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar, situated at 215.2 m above mean sea level with coordinates of 29º 10′N latitude and 75º 46′E longitudes. The details of materials and methods applied in the present study are as follows:

Collection and preparation and digestion of leaf samples. The nutrients content of leaf of pomegranate were estimated by sampling leaves at full maturity in month of August at chest height. Collected samples were washed in running tap water followed by 0.1% HCl and two washings with distilled water. The samples were surface dried and then oven dried at 70ºC for 48 hours. The dried samples were then grinded and sieved through muslin cloth for further analysis as per procedure suggested by Chapman (1964). Well grinded samples of known weight was digested for nutrient estimation of N, P and K using a diacid mixture of concentrated sulphuric acid and perchloric acid (4:1) as per procedure described by Jackson (1967).

Estimation of Nitrogen. Leaf nitrogen content was estimated by Nessler's reagent method as per standard procedure (Jackson, 1967) and values were expressed in per cent.

Estimation of Phosphorus. Leaf phosphorus content was estimated by Vanado-molybdo phosphoric acid yellow color method as described by Jackson (1971) and expressed in per cent.

Estimation of Potassium. Leaf potassium content was estimated from digested extract using Flame photometer as suggested by Piper (1966) and expressed in per cent.

Determination of iron, manganese and zinc. 5 ml of aliquot was taken from the digested solution and final volume was made up to 25 ml. Then the concentration of zinc, copper, manganese and iron was estimated with the help of atomic absorption spectrophotometer (AAS, ECIL, Hyderabad India), by using the method described by Pirzadeh *et al*. (2010) and the concentration was expressed as µg/g or ppm dry weight of plant sample.

RESULT AND DISCUSSION

In both years of experimentation, the data presented in Table 1 indicate that different integrated nutrient management treatments significantly affected nitrogen, phosphorus and potassium content in plant leaf. During 2020-21, maximum nitrogen (1.33%), maximum phosphorus (0.71%) and maximum potassium content in leaf (2.07%) was obtained with T_{21}-RDF 100% + FYM + *Azotobacter* + PSB which was at par with T_{14}-RDF 75% + FYM + *Azotobacter* + PSB, T_{20}- RDF 100% + PSB + *Azotobacter* and T_{19} - RDF 100% + PSB (150 ml/l/plant) and minimum was recorded in T_{22}-control. However, during 2021-22, T_{21}-RDF 100% + FYM + *Azotobacter* + PSB recorded maximum nitrogen (1.36%), maximum phosphorus (0.74%) and maximum potassium (2.11). It was at par with T_{14}-RDF 75% + FYM + *Azotobacter* + PSB, T_{20}- RDF 100% + PSB + *Azotobacter* and T_{19} - RDF 100% + PSB (150 ml/l/plant) and minimum was recorded in T_{22}-control leaf NPK content which showed an increase during the second year of experimentation. Such increase in NPK content in leaves may be due to synergistic effect of these applied nutrients which might have contributed to more absorption and translocation of NPK. This has resulted in higher uptake of these nutrients and maintained better harmony between photosynthesis and translocation which ultimately resulted in higher yield. The results of the present findings are in close agreement with those of Athani *et al.* (2007); Khan and Begum (2007); Naik and Babu (2007); Ram *et al.* (2007); Shukla *et al.*(2009); Dutta *et al.* (2009); Singh *et al.* (2009).

According to the pooled mean of data, T_{21} proved most effective in enhancing nitrogen (1.35%) phosphorus (0.73%) potassium (2.09%). Treatments T_{21} was found statistically at par with T_{14}- RDF 75% + FYM + *Azotobacter* + PSB and T_{20}- RDF 100% + PSB + *Azotobacter* during the experimentation. Minimum nitrogen (0.90%), minimum phosphorus (0.48%), minimum potassium (1.57) was observed in T_{22}-control.

The biofertilizers inoculation helps the plants to increase the dehydrogenase, alkaline\Nphosphatase, nitrogenase and hydrolysis enzymatic activities mainly due to increase in the rhizosphere microbial population as a consequence of the inoculation treatments (Aseri and Tarafdar 2006). Dehydrogense is involved in the oxidative cleavage of pyurvate (electrondonor) and pyruvateis decarboxylyzed to release the electrons to ferredoxin and resulted into release of ammonia (Powar and Daginwala 2004). Phosphatase in the soil environment are considered to play a major role in the mineralization process of organic phosphorus by catalyzing hydrolytic cleavage of inorganic phosphate groups from organic phosphorus compounds (Dick, 1980). The dehydrogenase enzyme catalyses the reduction of several compounds having triple bonds (Powar and Daginwala 2004). Thus nitrogen and phosphorus are available for increased uptake by plant, ultimately enhancing the leaf nutrient content. The pectinolytic enzymes soften the middle lamella of the cell wall and increase the mineral absorption resulting into increase in leaf nitrogen content.

The increased leaf nutrient status may also be attributed to the fact that biofertilizers in combination with organic manures improved the physical condition of soil, root development and more soil moisture retention which resulted in increased uptake of water and nutrients (Morselli *et al.*, 2004). The more availability of phosphorus content in guava leaves can be attributed to the fact that PSB acts as chelating agent and forms stable compounds with iron and aluminium, thereby releasing phosphorus to soil making it available for uptake by plants (Gogoi *et al.*, 2004). Sau *et al.* (2017) reported that NPK content in leaves were found to increase with the application of *Azotobacter chorococcum* + *Azospirillum brasilense* + AM (*Glomus musseae*) + Panchagavya 3% as compared to control plants due to the role of microorganisms in soil which improves the nutrient availability from source to sink *i.e.* from soil to plants (Zahir *et al.*, 2003).

Nitrogen is responsible for increased the efficiency of metabolic processes of the tree and thus encouraged the growth of the plant and other parts of the plant including fruit (Godage *et al.*, 2013). The nitrogen fixers and phosphorus solubilizers increased the availability of nitrogen and phosphorus by increasing their translocation from roots to fruit and leaves to fruit (Singh and Singh 2009).

Table 1: Effect of inorganic, organic and bio fertilizers on leaf nitrogen, phosphorus and potassium in pomegranate.

Treatments	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	0.86	0.89	0.88	0.51	0.54	0.53	1.62	1.65	1.64
T_2	0.88	0.91	0.90	0.51	0.55	0.53	1.64	1.67	1.66
T_3	0.91	0.93	0.92	0.52	0.55	0.54	1.67	1.70	1.69
T_4	0.92	0.96	0.94	0.54	0.57	0.56	1.70	1.74	1.72
T_5	0.97	1.01	0.99	0.55	0.58	0.57	1.78	1.80	1.79
T_6	1.11	1.15	1.13	0.60	0.63	0.62	1.91	1.98	1.95
T_7	1.15	1.17	1.16	0.62	0.65	0.64	1.93	2.00	1.97
T_8	0.94	0.99	0.97	0.54	0.57	0.56	1.73	1.77	1.75
T_9	0.98	1.03	1.01	0.55	0.58	0.57	1.81	1.83	1.82
T_{10}	1.00	1.04	1.02	0.56	0.59	0.58	1.84	1.89	1.87
T_{11}	1.02	1.05	1.04	0.56	0.59	0.58	1.83	1.87	1.85
T_{12}	1.19	1.23	1.21	0.63	0.68	0.66	1.98	2.01	2.00
T_{13}	1.21	1.25	1.23	0.65	0.69	0.67	1.99	2.03	2.01
T_{14}	1.27	1.33	1.30	0.69	0.72	0.71	2.05	2.08	2.07
T_{15}	1.04	1.07	1.06	0.57	0.60	0.59	1.85	1.91	1.88
T_{16}	1.06	1.09	1.08	0.57	0.61	0.59	1.87	1.93	1.90
T_{17}	1.09	1.12	1.11	0.58	0.61	0.60	1.89	1.95	1.92
T_{18}	1.17	1.20	1.19	0.62	0.66	0.64	1.95	2.01	1.98
T_{19}	1.24	1.29	1.27	0.66	0.70	0.68	2.01	2.04	2.03
T_{20}	1.25	1.31	1.28	0.67	0.71	0.69	2.03	2.06	2.05
T_{21}	1.33	1.36	1.35	0.71	0.74	0.73	2.07	2.11	2.09
T_{22}	0.82	0.97	0.90	0.46	0.49	0.48	1.56	1.58	1.57
CD at 5%	**0.11**	**0.13**	**0.09**	**0.06**	**0.07**	**0.04**	**0.07**	**0.07**	**0.05**

Table 2: Effect of inorganic, organic and bio fertilizers on leaf Fe, Mn and Zn in pomegranate.

Treatments	Fe (ppm)			Mn (ppm)			Zn (ppm)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	147.10	149.10	148.10	27.95	29.05	28.50	42.20	43.31	42.76
T_2	148.54	150.32	149.43	28.09	29.16	28.63	42.50	43.48	42.99
T_3	147.50	149.40	148.45	28.00	29.10	28.55	42.30	43.39	42.85
T_4	149.29	151.20	150.25	28.20	29.17	28.69	42.61	43.60	43.11
T_5	150.68	152.50	151.59	28.32	29.32	28.82	42.86	43.90	43.38
T_6	157.43	159.40	158.42	29.70	30.25	29.98	43.80	44.91	44.36
T_7	158.65	160.01	159.33	29.90	30.38	30.14	43.94	45.12	44.53
T_8	150.17	152.00	151.09	28.25	29.26	28.76	42.78	43.74	43.26
T_9	151.60	153.60	152.60	28.39	29.40	28.90	42.97	44.10	43.54
T_{10}	152.20	154.30	153.25	28.54	29.47	29.01	43.10	44.17	43.64
T_{11}	153.10	155.20	154.15	28.80	29.59	29.20	43.26	44.35	43.81
T_{12}	160.50	162.40	161.45	30.20	30.70	30.45	44.30	45.38	44.84
T_{13}	161.70	163.90	162.80	30.60	30.90	30.75	44.50	45.60	45.05
T_{14}	163.90	165.80	164.85	31.17	31.20	31.19	45.50	46.25	45.88
T_{15}	154.43	156.59	155.51	28.90	29.70	29.30	43.40	44.52	43.96
T_{16}	155.70	157.50	156.60	29.20	29.90	29.55	43.54	44.67	44.11
T_{17}	156.69	158.70	157.70	29.40	30.05	29.73	43.67	44.78	44.23
T_{18}	159.80	161.50	160.65	30.10	30.54	30.32	44.10	45.24	44.67
T_{19}	162.20	164.30	163.25	30.84	31.07	30.96	44.80	45.72	45.26
T_{20}	163.70	165.50	164.60	31.04	31.11	31.08	45.10	45.96	45.53
T_{21}	164.02	165.97	165.00	31.30	31.45	31.38	45.90	46.75	46.33
T_{22}	146.54	148.23	147.39	27.89	28.95	28.42	42.03	43.12	42.58
CD at 5%	**NS**	**NS**	**9.80**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

In both years of experimentation, the data presented in Table 2 indicate that different integrated nutrient management treatments significantly not affected Fe, Mn and Zn content in plant leaf.

CONCLUSION

From the present investigation it is inferred that integration of organic manures and biofertilizers and RDF had significant effect on Leaf NPK content during both years. Different integrated treatments failed to significantly affect leaf micronutrient content *i.e*. MN, Zn, Fe. However, values increased during second year of experimentation.

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Conflict of Interest. All the authors are declared that they don't have any conflict of interest regarding this paper.

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