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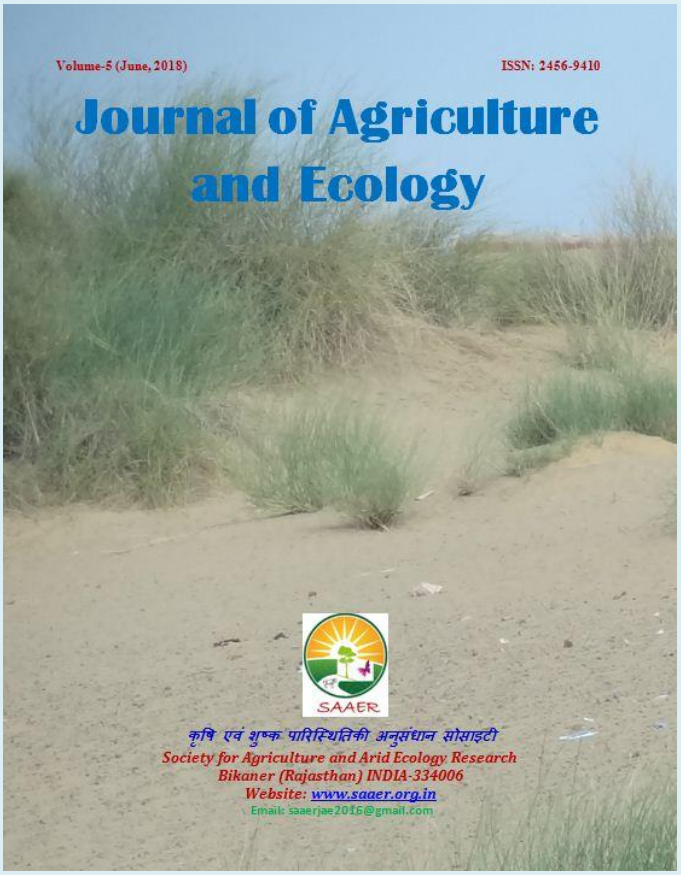

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Effect of integrated nutrient management on fruit quality of pomegranate cv. Ganesh

CL Meena, RK Meena*, DK Sarolia*, LK Dashora & D Singh**
Department of Horticulture, Rajasthan College of Agriculture, Udaipur-313 001
* ICAR-Central Institute for Arid Horticulture, Bikaner- 334 006
** Department of Horticulture, KA PG College, Allahabad (UP), India

Corresponding author: RK Meena, *E-mail* rkmeena8119@yahoo.com

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Abstract

A field experiment was conducted with integrated nutrient management treatments on 5 year old pomegranate cv. Ganesh. Total treatment combinations were seventeen viz, T_1-Recommended dose of NPK *i.e.* 500 : 200: 500 g NPK/plant, T_2- Vermicompost (10 kg/plant) + *Neem* cake (5 kg/plant) +*Karanj* cake (5 kg/plant), T_3-Vermicompost (10 kg plant) + 50% NPK, T_4-Vermicompost (10 kg/plant) + 50% NPK + *PSB* (20 g/plant), T_5-Vermicompost (10 kg / plant) + 50% NPK + *Azotobacter* (20 g/plant), T_6-*Neem* cake 5 kg + 50% NPK), T_7- *Neem* cake 5 kg + 50% NPK + *PSB* (20 g/plant), T_8-*Neem* cake 5 kg + 50% NPK + *Azotobacter* (20 g/plant), T_9-*Karanj* cake (5 kg / plant) + 50 % NPK, T_{10}-*Karanj* cake (5 kg / plant) + 50% NPK + *PSB* (20 g/plant), T_{11}- *Karanj* cake (5 kg / plant) + 50% NPK + *Azotobacter* (20 g/plant), T_{12}-Vermicompost (10 kg) + *Neem* cake 5 kg + 25% NPK, T_{13}- Vermicompost (10 kg) + *Neem* cake (5 kg) + 25% NPK + *PSB* (20 g/plant), T_{14}-Vermicompost (10 kg) + *Neem* cake (5 kg) + 25% NPK + *Azotobacter* (20 g/plant), T_{15}-Vermicompost (10 kg) + *Karanj* cake (5 kg / plant) + 25% NPK, T_{16}-Vermicompost (10 kg) + *Karanj* cake (5 kg / plant) + 25% NPK + *PSB* (20 g/plant) and T_{17}- Vermicompost (10 kg) + *Karanj* cake (5 kg / plant) + 25% NPK + *Azotobacter* (20 g/plant). Result revealed that combination of vermicompost @ 10 kg + 25 per cent recommended dose of NPK + 5 kg *Neem* cake+ *PSB* 20g per plant significantly increased the quality components of pomegranate fruits in terms of TSS (16.95 ◦ Brix) , TSS acid ratio (41.62), ascorbic acid (14.39 mg/100 g), total sugar (14.24%) and organoleptic score (8.51) as well as leaf and soil nutrient status as compared to recommended dose of NPK (500g : 200g: 500g).

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Introduction

Pomegranate (*Punica granatum* L.) is one of the important fruit crops of tropical and sub-tropical world. It is a native of Iran and the surrounding areas. The characteristic ability of the fruit to withstand harsh climatic condition makes it able to grow in hot arid region. It is grown for its cool and refreshing

juice. The ripe fruit of pomegranate contain 12-16 per cent sugar and 1.5-2.5 per cent acid. Infect, it contains more sugar than apricots, plums, peaches and oranges. Besides being commercially important it has some medicinal value and is considered beneficial for the patients of leprosy, dysentery and diarrhea. The rind of the fruit contains about 30 per cent tannin which can be used for tanning leather. India ranks first in pomegranate production (21.9 lakh tonnes) in the world (Indian Horticulture Database 2017), contributing 60-70% to the international pomegranate trade by exporting 1-2% of the production (Jadhav & Sharma 2007). In India, pomegranate is commercially cultivated in Maharashtra, Andhra Pradesh, Uttar Pradesh, Gujarat, Rajasthan, Tamil Nadu and parts of Karnataka where good quality fruits are produced due to dry and hot climatic conditions. In India, more than 70% of the total production is used as table purpose and there is a high demand of fresh fruits both in domestic and international market. For higher production of quality fruits in a sustainable manner application of nutrients at proper doses is very important. It is reality that proper dose of nutrients to be standardized for a set of agro-climatic conditions which in turn to be economically acceptable, viable and eco-friendly suitable. In India, most of the fertilizer recommendations in pomegranate on the basis of higher quantity of inorganic fertilizers like 500-1000 g N, 500 g P_2O_5 and 250-500 g K_2O plant/year (Saraf et al. 2004; Sharma et al. 2018). The INM have been recognized to influence fruit quality of pomegranate. Therefore, an investigation was conducted to study the effect of integrated nutrient management on fruit quality of pomegranate cv. Ganesh.

Materials and Methods

In order to enhance the productivity of pomegranate orchard, an investigation was under taken at Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan). The Experimental Block is located at 24^0 34′ N latitude and 73^o 42′ E longitude at an elevation of 582.17 meters above mean sea level. The soil of the experimental site is clay loam having soil pH of about 8.0 with electrical conductivity of 0.94 dSm^{-1} and 0.71 per cent organic carbon. The available N, P and K were 282.1, 23.0 and 305.94 kg ha^{-1} respectively. In fact, in arid and semiarid areas, low precipitation, extremes of temperature, high wind velocity, poor soil fertility, soil salinity etc. are the major constraints of farming. The pomegranate, though, it is a hardy plant to various biotic and abiotic stresses but needs proper management with respect to nutrition, moisture management and plant canopy architecture for obtaining economic return. In Rajasthan, *mrig bahar* crop is taken by withholding the water from May to June. In present investigation 5 years old pomegranate orchard of cultivar ‘Ganesh’ at distance of 4 x 6 m was selected for the experiment. The manure and fertilizer treatments were applied in middle of June during both the year of experimentation. The first light irrigation was given immediately after application of treatment and thereafter one or two light irrigation were given before the onset of rains. The trees start growth by July with onset of rains, flowers in August-September and produced fruits during winter season (December-January).

The experiment was laid out in Randomized Block Design (RBD) with four replications, considering four plants as treatment unit. The INM treatments comprised of inorganic fertilizers (NPK), organic manures (Vermi-compost and farm yard manure) and biofertilizers (*Azotobacter*, *Azospirillum* and PSB). The total treatment combinations were seventeen viz, 500 : 200: 500 g NPK/plant(T_1), T_2- Vermicompost(10 kg / plant) + *Neem* cake (5 kg / plant) +*Karanj* cake (5 kg / plant), T_3-Vermicompost (10 kg / plant) + 50% NPK, T_4-Vermicompost (10 kg / plant) + 50% NPK + *PSB* (20 g/plant), T_5-Vermicompost (10 kg / plant) + 50% NPK + *Azotobacter* (20 g/plant), T_6-*Neem* cake 5 kg + 50% NPK), T_7- *Neem* cake 5 kg + 50% NPK + *PSB* (20 g/plant), T_8-*Neem* cake 5 kg + 50% NPK + *Azotobacter* (20 g/plant), T_9-*Karanj* cake (5 kg / plant) + 50 % NPK, T_{10}-*Karanj* cake (5 kg / plant) + 50% NPK + *PSB* (20 g/plant), T_{11}- *Karanj* cake (5 kg / plant) + 50% NPK + *Azotobacter* (20 g/plant), T_{12}-Vermicompost (10 kg) + *Neem* cake 5 kg + 25% NPK, T_{13}-Vermicompost (10 kg) + *Neem* cake (5 kg) + 25% NPK + *PSB* (20 g/plant), T_{14}-Vermicompost (10 kg) + *Neem* cake (5 kg) + 25% NPK + *Azotobacter* (20 g/plant), T_{15}-Vermicompost (10 kg) + *Karanj* cake (5 kg / plant) + 25% NPK, T_{16}-Vermicompost (10 kg) + *Karanj* cake (5 kg / plant) + 25% NPK + *PSB* (20 g/plant) and T_{17}- Vermicompost (10 kg) + *Karanj* cake (5 kg / plant) + 25% NPK + *Azotobacter* (20 g/plant). Observations on quality characters were recorded as per standard methodology. The fully ripe fruits were selected for analysis of quality parameters namely TSS Brix^0, TSS: acid, ascorbic acid, total sugar and organoleptic score as well as leaf and soil nutrient status at harvest. The data on various parameters were analyzed with M-STAT statistical package to test the significance of the treatments.

Results and Discussion

Application of inorganic fertilizers, organic manures and biofertilizers significantly improved the nutritional quality of pomegranate fruits in terms of TSS, acidity, TSS/acid ratio and sugar content as compared to control (Table 1). It is further evident from the data that application of organic manure and biofertilizers proved significantly superior over inorganic fertilizers treatment. However, among various treatments, the application of 10 kg vermicompost + 5 kg *neem* cake + 25 % recommended dose of NPK + 20 g PSB (T_{13}) was found to be best treatment with respect to nutritional quality parameters of the fruit. This treatment also resulted in maximum TSS content of 16.95^0 Brix, minimum acidity of 0.41 per cent, highest TSS/acid ratio of 41.62, ascorbic acid content (14.39 mg/100g), reducing sugars (12.82%), non reducing sugar (1.35%), and total sugar (14.24%) (Table 1 & 2). These are in accordance with those of Yadav & Rathore (2004) in ber and Ram et al. (2007) in guava.

Table 1. Effect of INM on chemical characteristics of pomegranate cv. 'Ganesh'

Treatments	Organoleptic rating	Juice (%)	TSS (Brix$^{0)}$	Acidity (%)	TSS / Acid Ratio
T_1 -RDF of NPK (500 : 200: 500 g plant^{-1})	6.25	64.95	15.05	0.61	24.75

T_2- VC (10kg)+ NC (5kg) + KC (5kg)	5.95	64.85	14.75	0.59	25.08
T_3- VC(10 kg) +50% NPK	6.55	65.50	15.30	0.57	27.07
T_4- VC (10 kg) +25% NPK+PSB (20 g plant^{-1})	7.75	72.26	16.16	0.46	35.25
T_5- VC (10 kg) +25% NPK + *Azatobactor* (20 g plant^{-1})	7.75	71.80	16.11	0.48	33.85
T_6- NC (5 kg) +50% NPK	6.91	67.85	15.66	0.52	30.37
T_7- NC (5kg) +25% NPK+PSB (20 g plant^{-1})	7.41	69.46	15.85	0.50	32.16
T_8- NC (5 kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	7.01	69.03	15.73	0.50	31.29
T_9- KC (5 kg) +50% NPK	6.44	66.43	15.29	0.54	28.14
T_{10}- KC (5 kg) +25% NPK+PSB (20 g plant^{-1})	6.79	67.31	15.41	0.53	29.45
T_{11}- KC (5 kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	6.69	66.90	15.52	0.54	29.03
T_{12}- VC (10kg) + NC (5kg) +25% NPK	8.01	73.54	16.40	0.53	29.45
T_{13}- VC(10kg) + NC(5kg) +25% NPK+ PSB (20 g plant^{-1})	8.51	76.60	16.01	0.41	41.62
T_{14}- VC(10kg) + NC (5kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	8.34	76.26	16.87	0.45	36.59
T_{15}- VC(10kg) + KC (5kg) +25% NPK	7.41	70.96	16.95	0.54	29.03
T_{16}- VC (10kg) + KC (5kg) +25% NPK+ PSB (20 g plant^{-1})	8.11	76.30	16.71	0.42	40.75
T_{17}- VC (10kg) + KC (5kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	7.93	75.76	16.68	0.49	32.85
SEm±	0.16	1.51	0.20	0.43	39.37
CD (P=0.05)	0.46	4.23	0.56	0.44	38.15

VC=Vermicompost, NC= *Neem* cake, KC= *Karanj* cake RDF= Recommended dose of fertilizer

It is well documented fact that incorporation of organic manures in the soils not only acts as store house of major and micro nutrients but also favorably improve physical, chemical and biological properties of the soils. These results are in agreement with Ranjan and Ghosh (2005). Thus potential role of organic fertilization on various aspects of crop growth can be ascribed due to its direct effect on availability of vital nutrients along with physico-chemical and biological properties of soils and indirectly *via* release of growth hormones, vitamins and augmenting microbial population etc. during its process of

decomposition (Naik & Haribabu 2007; Ram & Rajput 2000). Similarly, the beneficial effect of *PSB* on fruit quality with respect to TSS and acidity might be due to phosphate solubilising bacteria that solubilise the insoluble forms of phosphorus and make them available to the plants. The mechanism of stabilization appears to be acid metal reaction and thus dissolution and chelation of metal and release of phosphorus. These are also known to produce acids, vitamins, growth promoting substances like IAA, GA_3, etc. which might improve the quality of fruits (Haneef et al. 2014).

Table 2. Effect of INM on reducing sugar, non reducing sugar and total sugar of pomegranate cv. 'Ganesh'

Treatment	Reducing sugars Content (%)	Non reducing sugars (%)	Total Sugar (%)	Ascorbic acid (mg/100 ml juice)
T_1-RDF of NPK (500 : 200: 500 g plant^{-1})	10.85	1.15	12.06	10.76
T_2- VC (10kg)+ NC (5kg) + KC (5kg)	10.82	1.14	12.03	10.52
T_3- VC(10 kg) +50% NPK	10.87	1.21	12.14	11.13
T_4- VC (10 kg) +25% NPK+PSB (20 g plant^{-1})	12.27	1.32	13.66	13.72
T_5- VC (10 kg) +25% NPK + *Azatobactor* (20 g plant^{-1})	12.11	1.31	13.49	13.60
T_6- NC (5 kg) +50% NPK	11.52	1.27	12.85	12.66
T_7- NC (5kg) +25% NPK+PSB (20 g plant^{-1})	11.86	1.30	13.23	13.21
T_8- NC (5 kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	11.77	1.29	13.13	12.76
T_9- KC (5 kg) +50% NPK	11.02	1.21	12.30	11.86
T_{10}- KC (5 kg) +25% NPK+PSB (20 g plant^{-1})	11.49	1.23	12.79	12.29
T_{11}- KC (5 kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	11.32	1.24	12.62	12.18
T_{12}- VC (10kg) + NC (5kg) +25% NPK	12.40	1.32	13.78	12.29
T_{13}- VC(10kg) + NC(5kg) +25% NPK+ PSB (20 g plant^{-1})	12.82	1.35	14.24	14.39
T_{14}- VC(10kg) + NC (5kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	12.71	1.34	14.12	13.84
T_{15}- VC(10kg) + KC (5kg) +25% NPK	11.97	1.31	13.35	12.18
T_{16}- VC (10kg) + KC (5kg) +25% NPK+ PSB (20 g plant^{-1})	12.62	1.34	14.03	14.30
T_{17}- VC (10kg) + KC (5kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	12.56	1.33	13.96	13.42
SEm±	0.18	0.04	0.18	14.14
CD (P=0.05)	0.50	0.11	0.49	14.05

Leaf nutrient status at harvest

The results of the experiment revealed that leaf nutrient status with respect to nitrogen; phosphorus and potassium content were increased over control after the termination of the trial due to various treatments (Table 3). The combined application of 10 kg vermicompost + 5 kg *neem* cake + 25 % recommended dose of NPK + 20g *PSB* was found to be significantly superior with 2.57 % N, 0.46 % P and 1.76 % K over 100 per cent recommended dose of NPK (1.85 % N, 0.35 % P and 0.37 % K). The leaf nutrient status was also significantly influenced by combined application of organic, inorganic and biofertilizers. The results of the present investigation are in conformity with the finding of Aseri et al. (2008) and Kumar & Sharma (2017) who reported importance of vermicompost in the crop production. The results of the present investigation are in close agreement with the finding of Kumar et al. (2005) and Meena & Bhati (2016) who also reported that the different levels of N, P and K fertilizers significantly influenced leaf nutrient status. Similarly, the application of *PSB* @ 20 g per plant significantly increased N and P status of leaf at harvest, whereas, the K content of leaf was non-significant. Our results are in close agreement with the findings of Ram et al. (2005) and Naik & Babu (2005) in guava.

Available NPK status of soil

The results of soil analysis at harvesting revealed that available nitrogen, phosphorus and potash content of soil significantly increased due to different treatments as compared to control (Table 3). The application of organic manures and biofertilizers were found to be significantly superior over 100 per cent recommended dose of NPK with respect to N and P. The data further reveal that application of different levels of NPK treatment significantly increased the available NPK content of soil. Among the different treatments combined application of 10 kg VCM + 5 kg *neem* cake + 25 % recommended dose of NPK + 20 g *PSB* showed higher fertility status of the soil in terms of 257.03 % N, 29.65 % P and 319.60 % K content of soil as against 100 per cent recommended dose of NPK (240.53 % N, 20.75 % P and 293.29 % K). It may be improvement in following use of vermicompost and neem cake. The results of the present investigation are in close agreement with the finding of Dey et al. (2005), who stated that the availability of phosphorus gets released from fixed phosphorus in the soil by the application of phosphate solubilising bacteria.

Table 3. Effect of INM on soil & leaf N P K status

Treatment	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Soil	Leaf	Soil	Leaf	Soil	Leaf
T_1-RDF of NPK (500 : 200: 500 g plant^{-1})	240.53	1.85	20.75	0.350	293.29	1.37
T_2- VC (10kg)+ NC (5kg) + KC (5kg)	240.58	1.83	20.76	0.343	293.30	1.35
T_3- VC (10 kg) +50% NPK	241.30	1.91	21.17	0.356	295.76	1.41
T_4- VC (10 kg) +25% NPK+PSB (20 g	251.30	2.37	26.56	0.431	313.78	1.63

plant^{-1})						
T_5- VC (10 kg) +25% NPK + *Azatobactor* (20 g plant^{-1})	250.20	2.30	25.45	0.422	313.33	1.61
T_6- NC (5 kg) +50% NPK	246.40	2.07	22.91	0.386	304.75	1.54
T_7- NC (5kg) +25% NPK+PSB (20 g plant^{-1})	248.50	2.14	24.16	0.407	309.13	1.58
T_8- NC (5 kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	247.16	2.09	23.80	0.397	308.53	1.56
T_9- KC (5 kg) +50% NPK	242.48	1.96	21.56	0.363	297.63	1.45
T_{10}- KC (5 kg) +25% NPK+PSB (20 g plant^{-1})	245.19	2.03	22.41	0.381	303.25	1.52
T_{11}- KC (5 kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	243.38	2.00	21.78	0.372	302.44	1.51
T_{12}- VC (10kg) + NC (5kg) +25% NPK	252.55	2.42	27.20	0.440	314.09	1.65
T_{13}- VC(10kg) + NC(5kg) +25% NPK+ PSB (20 g plant^{-1})	257.03	2.75	29.65	0.466	319.60	1.76
T_{14}- VC(10kg) + NC (5kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	255.51	2.67	28.78	0.458	319.18	1.73
T_{15}- VC(10kg) + KC (5kg) +25% NPK	249.43	2.21	24.66	0.415	309.66	1.59
T_{16}- VC (10kg) + KC (5kg) +25% NPK+ PSB (20 g plant^{-1})	254.14	2.59	28.38	0.453	316.69	1.70
T_{17}- VC (10kg) + KC (5kg) +25% NPK+ *Azatobactor* (20 g plant^{-1})	253.64	2.51	27.85	0.447	315.88	1.66
SEm±	3.23	0.03	0.30	0.006	3.34	0.02
CD (P=0.05)	9.05	0.07	0.84	0.016	9.37	0.06

From the discussion undergone it becomes quite clear that different nutritional treatments in pomegranate significantly affected the growth, yield and quality of fruit. Among the different organic manure, the investigation revealed that the vermicompost was superior over the other organic manures in improving vegetative growth, flowering fruiting, yield and yield attributes and fruit quality. Further, the organic manures improved the soil fertility and leaf nutrient status of guava plant. This is conformity with finding of Shukla *et al.* (2009) and Balai et al. (2017). Similarly, among the different levels of inorganic fertilizer, the application of 25 per cent recommended dose of NPK was found to be superior with respect to growth, flowering, fruiting and yield of pomegranate. The application of *PSB* @ 20 g per plant also improved the growth and yield of pomegranate. These treatments were also found most economic in terms of net return and benefit cost ratio. Therefore, based on the findings vermicompost @ 10 kg per plant, 25 per cent recommended dose of NPK and *PSB* @ 20 g per plant in the month of June may be applied in pomegranate to obtain higher yield and quality fruits in pomegranate. The maximum net return (178843.20 Rs./ha) and B/C ratio (3.72) recorded at T_{12} treatment *i.e.* 10 kg vermicompost + 5 kg *neem* cake + 25

per cent recommended dose of NPK + *PSB* @ 20 g/ plant.

References

Aseri GK, Jain N, Panwar J, Rao AV & Meghwal PR. 2008. Biofertilizers improve plant growth, fruit yield, nutrition, metabolism and rhizosphere enzymes activities of pomegranate (*Punica granatum* L.) in Indian Thar desert. *Scientia Horticulturae,* 117: 130-35.

Balai RC, Meena LR & Sharma SC. 2017. Effect of different levels of nitrogen and phosphorus on cowpea [V*igna unguiculata* (L.) Walp] under rainfed conditions of Rajasthan. *Journal of Agriculture and Ecology*, 3: 19-24.

Dey P, Kumar S, Das B & Nath V. 2005. Efficacy of biofertilizers in guava grown on acid soil. *1st International Guava Symposium*, Dec. 5-8, CISH, Lucknow, pp. 63-64.

Haneef M, Kaushik RA, Sarolia DK, Mordia A & Dhakar M. 2014. Irrigation scheduling and fergitaion in pomegranate cv Bhagwa under high density planting system. *Indian Journal of Horticulture*, 71:45–8.

Jadhav VT. and Sharma, J. 2007. Pomegranate cultivation is very promising. *Indian Hort*. 52:30-31.

Kumar P, Tiwari JP & Lal S. 2005. Effect of varying levels of N, P and K fertilization on plant growth, yield, fruit quality and leaf nutrient status of guava (*Psidium guajava* L.) cv. 'Pant Prabhat". *1st International Guava Symposium*. Dec. 5-8, CISH, Lucknow, pp. 80.

Kumar R & Sharma OC. 2017. Saffron (*Crocus sativus* L.) growth and yield as influenced by organic farming practices. *Journal of Agriculture and Ecology***,** 4:25-32.

Meena NK & Bhati A. 2016. Response of Nitrogen, Phosphorous and Potassium Levels on Growth and Yield of Okra [*Abelmoschus esculentus* (L.) Moench.]. *Journal of Agriculture and Ecology*, 2: 17-24.

Naik MH & Babu RSH. 2005. Feasibility of organic farming in guava. *1st International Guava Symposium*, Dec., 5-8, CISH, Lucknow, pp. 69

Naik MH & Haribabu RS. 2007. Feasibility of organic farming in guava (*Psidium guajava* L.). *Acta. Horticulturae.* 735:365-72.

Ram RA & Rajput MS. 2000. Role of biofertilizers and manures in production of guava (*Psidium guajava* L.) cv. 'Allahabad safeda'. *Haryana Journal of Horticultural Sciences*, 29:193-194

Ram RA, Bhriguvanshi SR & Pathak RK 2005a. Integrated plant nutrient management in guava (*Psidium guajava* L.) cv. 'Sardar'. *1st International Guava symposium*, Dec. 5-8, CISH, Lucknow, pp. 85.

Ram RA, Bhriguvanshi SR & Pathak, RK 2007. Integrated plant nutrient management in guava (*Psidium guajava* L.) cv. Sardar. *Acta Horticulturae*. 735: 345-50.

Ranjan K, Tarai & Ghosh SN. 2005. Effect of nitrogen levels on yield, fruit quality and foliar NPK status of aonla grown on

laterite soil. *Indian Journal of Horticulture*, 64:394-95

Saraf RK, Samaiya RK & Shukla KC. 2004. Effect of different sources of nutrients on growth of pomegranate. *Proceedings of National Conference on Biodiversity and Sustainable Utilization of Biological Resources*, pp. 203-8.

Sharma SC, Balai RC & Sahoo A. 2018. Effect of pasture type, phosphorus levels and phosphate solubilizing bacteria on forage productivity under agroforestry system in semi-arid regions. *Journal of Agriculture and Ecology*, 5: 42-49.

Shukla AK, Sarolia DK, Kumari B, Kaushik RA, Mahawer LN, & Bairwa HL. 2009. Evaluation of substrate dynamics for integrated nutrient management under high density planting of guava cv. Sardar. *Indian Journal of Horticulture, 66(4), 461-464*

Yadav PK & Rathore PS. 2004. Effect of foliar spray of thiourea and ferrous sulphate on the yield and quality of *ber* fruit. *Progressive Agriculture,* 4:85-86.