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Integrated nutrient management in pomegranate grown in laterite soil

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ABSTRACT

To produce good quality pomegranate in larger quantity, an experiment was conducted on 5-year-old plants of cv. Ruby in a private orchard at Jhargram, Paschim Midnapore where soil is laterite and climate is sub-tropical. There were nine manurial treatments which consisted of organic manures and inorganic fertilizers, applied individually and in combination following R.B.D. Three consecutive years of study indicated that FYM was better than vermicompost with regard to improvement in plant growth and fruit production. Plant growth in respect of basal girth and canopy was highest in plant where FYM (20 kg/plant) was applied singly or combined with inorganic fertilizers. Highest yield (8.1 kg/plant) was recorded in plant where FYM 20 kg along with $N_{400}P_{100}K_{300}$ g/year was applied that was associated with the foliar N/K ratio of 1.3. The treatment also resulted in maximum fruit weight (200 g) with the highest TSS (14.8°B), reducing sugar (12.0%) and vit. C (12.5 mg/100 ml) content. The fruits from organic fertilized plant showed maximum storage life with less PLW.

Key words: Pomegranate, integrated nutrient management, laterite soil, quality, storage.

INTRODUCTION

Pomegranate (*Punica granatum* L.) of the family Punicaceae is one of the favourite table fruits in the world for its refreshing juice having nutritional and medicinal properties. This fruit crop has wide adaptability and it grows in tropical, sub-tropical and even in temperate regions. India ranks first in pomegranate production (11.4 lakh tonnes) in the world, contributing 60-70% to the international pomegranate trade by exporting 1% of the production (Jadhav and Sharma, 6). In India, pomegranate is commercially cultivated in Maharashtra and parts of Karnataka where good quality fruits are produced due to dry and hot climatic conditions. The crop is also being cultivated in other states, and in West Bengal, the crop has been introduced in the red and laterite zone of the state where the climate is dry and sub-tropical in nature (Tarai and Ghosh, 15). 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 (Singh *et al*., 14; Banker *et al*., 2; Prasanna and Dhander, 9). Use of such higher quantity of N, P, K although helpful for increasing the production but may have deleterious effect on the soil environment. Very little published literature is available regarding integrated use of inorganic and organic nutrients in pomegranate in an acceptable approach and no such report is available for West Bengal conditions. Therefore, an investigation was undertaken.

MATERIALS AND METHODS

The investigation was carried out in a private orchard, Jhargram, Paschim Midnapore district of West Bengal during the period 2006 to 2009 on pomegranate 'Ruby', planted at a spacing of 3 m × 3 m. The site is in sub-tropical climate with average precipitation (June to October) about 1,100 mm. The soil of the orchard was laterite having pH 6.0, cation exchange capacity 17.0 mili-eq./100 g soil, available nitrogen, phosphorus and potassium was 330 k, 32 and 200 kg per ha respectively. The organic carbon content was 0.56% and available zinc, boron and iron were 3.9, 0.8 and 28.0 ppm, respectively (DTPA extractable). The treatment consisted of N_{200} P_{100} K_{100} g (low level of N, P, K), N_{400} P_{100} K_{300} g (high level of N and K), FYM 20 kg, vermicompost (VC) 4 kg, FYM 20 kg + N_{200} P_{100} K_{100} g, FYM 20 kg + N_{400} P_{100} K_{300} g, VC 4 kg + N_{200} P_{100} K_{100} g, VC 4 kg + N_{400} P_{100} K_{300} g per plant / year and control (without any manure and fertilizer). There were nine treatments which were replicated four times in randomized block design

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with four plants in each treatment. The manures and fertilizers were applied in circular basin in two splits, *i.e.*, in December and February. Sources of N, P and K were urea, single super phosphate and muriate of potash, respectively. Observations on plant growth, fruit yield, physico-chemical characteristics, incidence of fruit cracking and foliar N, P and K contents were made. Storage behaviour in respect of shelf-life and physiological loss in weight (PLW) of fruits in different treatments was observed under normal room temperature. The room temperature was noted 31 to 34°C as maximum and 28 to 31°C as minimum during the period of observation.

RESULTS AND DISCUSSION

The results presented in Table 1 revealed that the rate of growth of plant in respect of height, was maximum (61.7%) with N_{400} P_{100} K_{300} g/ plant closely followed by FYM 20 kg/ plant + N_{200} P_{100} K_{100} g/plant (60.4%) and lowest (43.2%) in control (Table 1). Growth in basal girth was highest (33.9%) in plants with FYM 20 kg closely followed by VC 4 kg + N_{400} P_{100} K_{300} g (33.6%) and N_{400} P_{100} K_{300} g (32.0%). The canopy growth has been observed better in plants with FYM (20 kg/plant) singly or combined with inorganic fertilizers as compared to sole inorganic fertilizers application (Table 1). The result was close conformity with the findings of Saraf *et al*. (11) who also observed that FYM singly or in combination with other inorganic nutrients improved the growth of pomegranate plants.

Judicious application of nutrients is necessary not only for sustainable production of quality fruits but also to save our costly soil. Experiment conducted with inorganic and organic sources of nutrients revealed that farm yard manure (FYM) at 20 kg/plant gave highest yield of 7.5 kg (Av. three years) as against same quantity (7.5 kg) obtained from inorganic sources, *i.e.*, N_{400} P_{100} K_{300} g/plant (Table 1). It was further noted that effectiveness of inorganic fertilizers was greatly enhanced when it was applied along with FYM which may be because of the organic matter helps to retain urea in the root zone (Mistsui *et al*., 7; Chin and Kroonje, 4) and in marking the phosphate and potash available to plants (Raychoudhuri, 10). It was noted that VC (4 kg/plant) was less effective in yield improvement as compared with FYM which may be due to lower quantity of the costly manure. It may be mentioned that good quality VC is available in the market at the rate of to Rs. 12/- to 15/- a kg. It was noted that fruit yield in most of the treatments (Table 1) increased with the aging of plants and highest average yield (8.1 kg/plant) was recorded from the plant fertilized with FYM 20 kg + N_{400} P_{100} K_{300} g. The lowest average yield (3.2 kg/ plant) was recorded from control plant.

Fruit weight was highest (200 g) in the plants, received FYM 20 kg + N_{400} P_{100} K_{300} g/plant and lowest (148 g) in control plant (Table 2). It was noted that effect of FYM was better as compared to VC in weight increment. Fruit size in respect of breadth was not significantly varied among the different treatments (Table 2). Fruit cracking in pomegranate is experienced by many growers and its intensity varied from variety to variety and even in different locations

Table 1. Effect of organic manures and inorganic fertilizers on plant growth and fruit yield in pomegranate cv. Ruby.

Treatment	Plant growth (percentage of promotion in 3 years)				Fruit yield/plant (kg) at the age of			
	Height	Basal girth	Plant spread		5th year	6th year	7th year	Average
			East - West	North - South				
N_{200} P_{100} K_{100} g	50.0	12.8	50.0	49.4	3.8	7.1	5.0	5.3
N_{400} P_{100} K_{300} g	61.7	32.0	56.3	50.3	6.4	6.1	10.1	7.5
FYM – 20 kg	48.8	33.9	96.0	66.4	6.6	8.0	7.8	7.5
FYM – 20 kg + N_{200} P_{100} K_{100} g	60.4	22.5	78.1	63.8	4.5	7.1	9.9	7.2
FYM 20 kg + N_{400} P_{100} K_{300} g	59.6	16.7	85.2	58.4	4.7	6.2	13.4	8.1
Vermicompost (VC) – 4 kg	47.0	10.1	65.6	56.8	4.0	4.5	8.9	5.8
VC 4 kg + N_{200} P_{100} K_{300} g	55.0	20.0	52.2	60.6	5.8	7.9	4.0	5.9
VC 4 kg + N_{400} P_{100} K_{300} g	54.2	33.6	79.0	60.5	6.2	8.0	6.8	7.0
Control – No manures & fertilizers	43.2	8.5	33.2	32.4	3.8	2.3	3.4	3.2
CD at 5%	5.5	3.2	6.7	7.2	0.2	0.3	0.4	0.3

Table 2. Effect of organic manures and inorganic fertilizers on physico-chemical characteristics of fruits and nutrient status in pomegranate cv. Ruby.

Treatment	Fruit weight (g)	Fruit breadth (cm)	Fruit cracking (%)	Juice (%)	TSS (°B)	Acidity (%)	TSS/ acid ratio	Reducing sugar (%)	Vit. C (mg/100 ml)	Foliar content (on dry weight basis)		
										N (%)	P (mg %)	K (%)
N_{200} P_{100} K_{100} g	154	7.5	1.1	74	14.3	0.42	34.0	10.4	9.6	1.0	110	0.8
N_{400} P_{100} K_{300} g	191	8.2	0.0	73	14.5	0.39	37.2	10.3	9.0	1.5	139	1.2
FYM – 20 kg	172	7.8	0.0	75	13.3	0.42	31.7	10.8	10.6	1.4	110	0.9
FYM – 20 kg + N_{200} P_{100} K_{100} g	185	7.7	0.0	77	14.8	0.42	35.2	11.8	12.3	1.3	110	1.1
FYM – 20 kg + N_{400} P_{100} K_{300} g	200	8.0	0.0	74	14.8	0.42	35.2	12.0	12.5	1.6	110	1.2
Vermicompost (VC) – 4 kg	164	7.7	2.4	73	13.7	0.43	31.9	11.1	10.4	1.3	120	0.9
VC 4 kg + N_{200} P_{100} K_{100} g	180	8.0	0.0	74	13.4	0.45	29.8	9.9	8.9	1.4	143	1.2
VC 4 kg + N_{400} P_{100} K_{300} g	158	7.6	0.0	72	13.2	0.53	24.9	9.8	10.0	1.4	112	1.5
Control – No manures & fertilizers	148	7.4	5.0	70	12.5	0.44	28.4	9.0	8.2	0.5	87	0.8
CD at 5%	4.5	N.S.	N.S.	1.1	0.4	N.S.	–	0.3	1.1	0.2	6.2	N.S.

*Average of 3 years

Table 3. Effect of organic manures and inorganic fertilizers on storage behaviour of pomegranate cv. Ruby.

Treatment	Storage (days after harvest)																					
	3 day		7 day		10 day		14 day		18 day		22 day		26 day		30 day		34 day		38 day		42 day	
	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)	Rot (%)	PLW (%)
N_{200} P_{100} K_{100} g	0	10.6	0	20.6	0	23.1	20	26.9	20	28.8	20	31.9	20	33.1	20	35.0	70	36.3	80	39.4	100	42.5
N_{400} P_{100} K_{300} g	0	12.7	0	21.2	0	25.4	10	30.7	10	32.8	20	34.9	60	37.0	70	39.7	80	41.3	80	43.4	100	45.5
FYM – 20 kg	0	9.7	0	17.3	0	20.5	0	23.9	0	26.2	10	27.9	40	29.1	40	30.9	40	32.6	50	34.0	100	36.1
FYM – 20 kg + N_{200} P_{100} K_{100} g	0	8.3	0	21.0	0	24.9	0	30.3	10	31.6	10	34.7	20	36.8	30	38.1	40	40.2	60	41.7	100	43.3
FYM – 20 kg + N_{400} P_{100} K_{300} g	0	9.7	0	18.0	0	20.9	10	24.9	10	26.9	10	29.2	20	30.9	20	32.2	40	33.9	70	35.4	100	37.2
Vermicompost (VC) – 4 kg	0	9.0	0	20.0	0	22.7	0	26.9	0	28.2	10	30.3	30	32.1	30	33.6	50	35.5	60	37.4	100	38.8
V.C. 4 kg + N_{200} P_{100} K_{100} g	0	10.7	0	22.1	0	26.4	10	31.1	10	32.8	10	35.8	20	38.6	40	40.1	40	42.0	60	45.5	100	48.3
V.C. 4 kg + N_{400} P_{100} K_{300} g	0	8.4	0	19.5	0	22.8	20	27.2	30	28.5	30	30.9	40	32.9	60	34.6	70	36.6	80	38.6	100	40.6
Control No manures & fertilizers	0	9.2	0	18.8	0	22.8	10	28.7	10	30.5	30	33.1	40	36.0	40	37.9	70	40.1	80	42.3	100	43.8
CD at 5%	–	0.4	N.S.	0.8	N.S.	1.1	0.9	1.8	3.5	5.5	4.8	6.0	5.8	6.4	7.0	4.4	8.0	3.2	5.8	4.9	N.S.	5.7

of same variety. Fruit cracking, which is reported to be related with the soil moisture fluctuation (Hayes, 5), was possible to reduce or minimize to some extent with the nutritional management (Table 2). No fruit cracking was observed in plants where FYM or FYM + inorganic fertilizers were applied while in control plants, 5 per cent fruit cracking was observed. Singh *et al.* (13) also opined that the plants mulched with FYM exhibit lowest fruit cracking as compared to irrigation and other treatments. From the discussion, it is cleared that organic manure like FYM not only maintained the plant health and fruit production but also help to reduce the physiological yield loss like fruit cracking. Beneficial role of FYM in reducing fruit cracking may be explained from the fact, that it contains most of the macro- and micro- nutrients in lower quantity that increase the cell wall turgidity and protect the fruits against abiotic stress.

Fruit quality in respect of TSS, reducing sugar, and vitamin C contents was significantly improved due to application of organic manures and inorganic nutrients singly or in combination (Table 2). Highest TSS (14.8°B), reducing sugar (12.0%) and vitamin C (12.5 mg/ 100 ml) contents were estimated from the fruits of the plants fertilized with FYM 20 kg + N_{400} P_{100} K_{300} g per plant/year. Lowest TSS (12.5°B), reducing sugar (9.0%) and vitamin C (8.2 mg/ 100 ml) were measured from the fruits of control plants. A number of reports were available regarding fruit quality improvement in pomegranate due to inorganic fertilizer application (Sen and Chouhan, 12; Pathak and Pundir, 8) but little published literature is available to elucidate the beneficial effect of organic manures in singly or combine with inorganic fertilizers regarding quality improvement in pomegranate.

Leaf nutrient status, which is considered to be an indicator tool for nutrient management programme in fruits crops (Bhargava, 3) was significantly varied due to different treatments. Highest foliar nitrogen (1.6%) content was measured from the plant fertilized with FYM 20 kg + N_{400} P_{100} K_{300} g. Lowest N was estimated in control plant (0.5%). Phosphorus content in leaves was maximum in plant with VC + N_{200} P_{100} K_{100} g (143 mg %) followed by N_{400} P_{100} K_{300} g (139 mg %) and minimum in control (87 mg %). Potassium content in leaves did not varied significantly in different treatments.

A beneficial and positive effect of manures and fertilizers was noticed in storage behaviour of fruits which is considered to the important in business and marketing point of view. In general, organic manures treated fruits have higher storage life with lower PLW as compared to inorganic fertilizer's treatment. Among the different treatments, FYM 20 kg/plant/year was found to be the best as the fruits under this treatment had highest storage life of 18 days with no fruit rot having lowest PLW (26.2%) followed by vermicompost (Table 3). In general, PLW and fruit rot in most of the treatments had started from 14 days of storage and it increased with the advancement of storage duration irrespective of the treatments. In higher storage duration of more than 22 days, the fruits were shriveled and discoloured but taste was good due to water loss, irrespective of treatments.

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