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Effect of controlled-release fertilizers on growth, yield and fruit quality of guava cv. Sardar in Ustochrepts

R.A. RAM, M.S. RAJPUT and S.R. BHRIGUVANSHI

Central Institute for Subtropical Horticulture, Rehmankhera, P.O. Kakori, Lucknow 227 107

INTRODUCTION

The efficiency of fertilizer use is often expressed in terms of percentage of recovery of the applied fertilizer. Often, less than 50% of the nitrogenous fertilizer applied to the crops may be utilized by the plants (Allison, 1). Direct loss results from application in excess of crop needs or application at the wrong time, wrong place, or with the wrong material. Indirect N losses are caused by leaching, erosion, volatilization, denitrification and to a lesser extent by fixation (Cooke, 5). Soil characteristics, climatic conditions, cropping practices, fertilizer source and method of fertilizer application affect the nutrient uptake. Besides, poor recovery of N by plants is a result of rapid dissolution of applied fertilizer and release of mineral N and movability of nitrate ions, than what is used by the plants or conserved by the soil in available forms. Among the various strategies explored to increase the N-use efficiency, application of controlled-release N-carrier is one. Guava is a subtropical fast-growing, remunerative fruit crop, which owing to its responsiveness to manures and fertilizers, deserves the application of controlled release fertilizer. Researches have also showed that fruit crops remove less nutrients from the soil than cereals and vegetable crops, perhaps due to low plant population per unit area. Keeping these points in view, a field experiment was laid out to study the effect of controlled-release fertilizers on growth, yield and fruit quality of guava cv. Sardar.

MATERIALS AND METHODS

A field experiment was started with newly established plants of guava cv. Sardar. In the first 2 years, equal doses of N, P and K [100 g each of urea (46.4% N), single superphosphate (16% P_2O_5) and muriate of potash(60% K_2O) in 1993; and 200 g each of urea, single superphosphate and muriate of potash in 1994] were applied to all experimental plants to bring uniformity in soil rhizosphere and nutrient status of the plants. Total available N (Walkley and Black, 14), available phosphorus (Olsen *et al.,* 11) and exchangeable potassium (Jackson, 7) were determined in soil before the treatment application (Table 1). The experimental soil was coarse sandy loam, hyperthermic, typic Ustochrepts class with pH 7.72 and electrical conductivity ranging from 0.11 to 0.17 dS/m. The N, P and K contents in the leaves also were determined before (1.44% N, 0.14% P and 0.71% K in composite sample) and after the application of treatments (Table 2). Leaf nitrogen was estimated by the micro-Kjeldahl apparatus (Tandon, 13), phosphorus content was determined by phosphomolybdovanadate yellow-colour method and was read at 670 nm in spectrophotometer (Jackson, 7). The potassium content in leaf was determined by flame-photometer (Tandon, 13). Three levels each of urea, urea supergranule and neem-coated urea (dissolution rate 169, 218 and 320.6 hours at 25°C respectively, and all containing 46.4% N) i.e. 200, 400 and 600 g/plant were applied in trench (15 cm deep and 75 cm away

Table 1. Nutrient status of soil before the treatment application.

Depth of soil (cm)	Total N (%)	P_2O_5 (kg/ha)	K_2O (kg/ha)
Basin			
0-30	0.04	6	72
30-60	0.04	6	114
Interspace			
0-30	0.04	6.8	70
30-60	0.04	6.4	76

Table 2. Leaf nitrogen, phosphorus and potassium content as influenced by different levels and sources of nitrogen (expressed as percentage of dry weight).

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Urea (200 g)	1.54	0.18	1.22
Urea (400 g)	1.58	0.18	1.15
Urea (600 g)	1.61	0.18	1.15
Urea supergranule (200 g)	1.52	0.20	1.22
Urea supergranule (400 g)	1.73	0.19	1.15
Urea supergranule (600 g)	1.68	0.19	1.22
Neem-coated urea (200 g)	1.84	0.17	1.20
Neem-coated urea (400 g)	1.92	0.19	1.25
Neem-coated urea (600 g)	2.10	0.19	1.50
Control	1.40	0.18	1.32
C.D. at 5%	0.09	0.021	0.076

from the trunk) when the plants attained the age of 3 years. All the sources of nitrogen were given in two equal split doses (i.e. in March and September). A fixed dose of 200 g each of single superphosphate and muriate of potash was applied to each plant with the first split dose of nitrogen. The experiment was laid out in randomized block design with three replications. Correlation matrix was worked out among all the vegetative parameters of the plants before the treatment application (Table 3). Observations on increase in plant growth characters, were recorded annually. Increase in plant nutrient status was also determined 2 months after beginning the treatments (Table 2). Observations on fruit size, weight and yield attributes were also recorded. In fruit-quality analysis, total soluble solids (°Brix) was recorded with the help of a refractometer. Reducing sugar was determined by copper-reduction method (Lane and Eynon, 10). Total titratable acidity was determined with N/10 NaOH, using phenolphthalein as indicator. Ascorbic acid content in freshly harvested fruit was

Table 3. Correlation matrix of vegetative growth characters before treatment application.

Characters	Height	Basal girth	Plant spread (east-west)	Plant spread (north-south)
Height	1	-	-	-
Basal girth	0.14	1	0.67	0.71
Plant spread (east-west)	0.35	-	1	-
Plant spread (north-south)	- 0.10	-	0.78	1

determined as mg/100 g fruit (Johnson, 9). The experimental data were analysed statistically following the analysis of variance method given by Panse and Sukhatme (12).

RESULTS AND DISCUSSION

Vegetative growth

Correlation matrix among all possible pairs of growth characters [plant height, basal girth, plant spread (eash-west) and plant spread (north-south)] were worked out in first 2 years (Table 2). Negative correlation was recorded (-0.10) between plant spread (y) (N-S) and plant height (x), whereas high correlation between plant spread N-S (y) and spread E-W (x), girth (y) and spread N-S (x). Annual increase in vegetative growth was significantly affected by the application of controlled release fertilizers and urea. Maximum increase in plant height in 1993 and 1994 was recorded with 600 g neem-coated urea, which was 5 and 19% (in 1993 and 1994 respectively) more than with 600 g urea treatment and 176 and 199% (in 1993 and 1994 respectively) more than with

Table 4. Vegetative growth as influenced by different levels and sources of nitrogen.

Treatments	Plant height (cm)		Annual increase (cm)		Plant spread (cm) East-west		Plant spread (cm) North-south	
	1993	1994	1993	1994	1993	1994	1993	1994
Urea (200 g)	42.8	84.3	5.3	11.5	270	237	110	237
Urea (400 g)	49.3	85.3	6.3	16.5	321	211	140	230
Urea (600 g)	58.8	107.6	7.1	18.1	334	287	162	269
Urea supergranule (200 g)	28.7	87.2	3.8	10.5	325	185	107	191
Urea supergranule (400 g)	41.8	93.6	5.7	12.7	326	220	128	232
Urea supergranule (600 g)	57.5	112.9	6.3	15.8	360	236	145	237
Neem-coated urea (200 g)	38.3	86.0	5.0	14.2	252	206	93	231
Neem-coated urea (400 g)	47.5	102.7	5.7	17.8	290	252	138	161
Neem-coated urea (600 g)	61.8	127.7	6.5	20.5	381	269	163	294
Control	22.4	42.8	2.8	7.6	146	132	59	140
C.D. at 5%	15.37	14.84	1.82	3.35	3	39	14	56

the control (Table 4). Stem girth also increased significantly with 600 g neem-coated urea in both the years. Though in the first year it was 9% lower than with 600 g urea and 130% more than with the untreated plants, in the second year the increase with 600 g neem-coated urea was higher than with the highest treatments of urea and urea supergranule. The highest increase in plant spread (East-West) was recorded with 600 g neem-coated urea in both the years, whereas in untreated plants the increase was the least. Maximum increase under north-south canopy spread was recorded with 600 g neem-coated urea, which was 0.5 and 9% more than with 600 g urea treatment and 130.1 and 169.4% more than with the untreated plants in first and second year respectively. The highest increase in overall growth of plants in 600 g neem-coated urea treatment was possibly due to the availability of nitrogen for a longer period in the rhizosphere, combined with higher dose, which led to higher recovery. In sour orange seedling, shoot growth was increased by using controlled release fertilizers (Fucik, 6). Similar results were also reported by Conover and Poole (4) that 40-80% shade (spread) was produced by *Ficus benjamina* with 16 g Osmocote (3-4 months dissolution) and influence of controoled release fertilizer sources on growth and quality of *Philodendron oxycardium* was studied by Trapp (14) and Conover and Poole (3), who found that Osmocote produced better plant growth. Waters and Llewellyn (16) concluded that controlled-release Osmocote was effective in maintaining low soluble salts which led to greater absorption and ultimately better growth.

Size and weight of fruits

Fruit diameter and fruit length increased with an increase in fertilizer doses (Table 5). However, no definite pattern was observed in fruit size than when the sources of fertilizers were combined. Increase in fruit size in all the treatments was higher than in the control (Table 5). Maximum fruit length (7.6 cm and 6.4 cm in first and second year respectively) was recorded with 600 g urea and urea supergranule, which were signifi-

Table 5. Physical characteristics of fruits as influenced by different levels and sources of nitrogen.

Treatments	Fruit diameter (cm)		Fruit length (cm)		Weight of individual fruit (g)	
	1993	1994	1993	1994	1993	1994
Urea (200 g)	6.6	5.2	6.8	5.3	187	208
Urea (400 g)	7.4	5.4	7.3	5.9	243	214
Urea (600 g)	7.8	5.9	7.6	6.4	272	212
Urea supergranule (200 g)	6.5	5.5	6.5	5.3	179	195
Urea supergranule (400 g)	7.8	5.7	7.2	5.8	215	208
Urea supergranule (600 g)	8.0	6.0	7.6	6.4	282	217
Neem-coated urea (200 g)	6.9	6.2	7.3	5.2	148	216
Neem-coated urea (400 g)	7.6	6.2	7.3	5.8	240	216
Neem-coated urea (600 g)	7.9	5.6	7.5	5.6	284	250
Control	6.1	4.8	6.5	4.5	200	176
C.D. at 5%	0.65	0.84	0.64	0.82	12	30

cantly higher than in the control. In general, variations among the different treatments were statistically not significant. Similar results were found in Golden Delicious apple on M 9 rootstock. Fruit diameter was reportedly increased by all formulations of sulphur-coated urea (7, 15 and 30% dissolution in 30 days). Significant increase in fruit weight was recorded at the highest levels of all three sources of nitrogen, which varied significantly in comparison with the control. Maximum fruit weight (282.5 g) was recorded with 600 g urea supergranule in the first year and 250.4 g in the second year with 600 g neem-coated urea, whereas in untreated plants, the average fruit weight was 200 g (in 1993) and 176.9 g (in 1994). There is report of increase in fruit size of strawberries when N was supplied from metal ammonium phosphate.

Number of fruits and yield

Significant increase in number of fruits and yield was recorded with treatments of slow releasing fertilizers and urea (Table 6). Maximum number of fruits (102) was harvested from the plants treated with 600 g neem-coated urea, followed by 93 fruits with 600 g urea supergranule. But only 10 fruits were recorded in untreated plants in the first year of experimentation. In the second year, the maximum fruits (125) were recorded with 600 g neem-coated urea, which was 36% more than with 600 g urea 33% more than with 600 g urea supergranule and 468% more than with the control. Yield per plant with 600 g neem-coated urea was 57 and 155% more than with 600 g urea treatment during 1993 and 1994 respectively, whereas minimum (1.9 kg and 3.8 kg) was observed in the control. Yied per hectare was calcualted to be 7.8 t and 8.8 t/ha (in 1993 and 1994) with 600 g neem-coated urea, which was 57 and 97% more than with 600 g urea treatment. In general, variations due to different levels of three sources of nitrogen were found significant in the first year, but those among highest and lowest doses of fertilizers alone, were found significant in the second year (Table 6). James (8) reported that after 22 months, banana fertilized with urea produced about 330 kg additional banana per plot or 19.8 tonnes. Yield from straw-

Table 6. Number of fruits and fruit yield/plant as influenced by different levels and sources of nitrogen.

Treatments	Number of fruits/plant		Yield (kg/plant)		Yield (t/ha)	
	1993	1994	1993	1994	1993	1994
Urea (200 g)	35	31	8.4	6.4	2.3	1.8
Urea (400 g)	62	57	11.2	12.3	3.1	3.4
Urea (600 g)	80	92	18.1	12.5	5.0	4.9
Urea supergranule (200 g)	21	30	4.4	5.9	1.2	1.7
Urea supergranule (400 g)	48	50	9.2	10.2	2.6	2.8
Urea supergranule (600 g)	93	60	38.6	12.9	7.4	3.6
Neem-coated urea (200 g)	13	57	5.9	12.5	1.6	3.4
Neem-coated urea (400 g)	37	92	10.3	19.8	2.8	5.5
Neem-coated urea (600 g)	102	125	28.4	31.9	7.9	8.8
Control	10	22	2.0	3.8	0.5	1.1
C.D. at 5%	48.5	31.6	17.1	10.5	0.06	3.2

ably by the application of different sources of nitogen. Leaf-nitrogen content was 1.44% before the treatment application, which ranged from 1.40 (control) to 2.10% after the treatment. With the increase in level, the leaf-N content also increased. Maximum N (2.10%) was recorded with 600 g neem-coated urea and a minimum (1.40%) with untreated plants (Table 2). In orange, it was reported that leaf-nitrogen content increased within 10-15 days of application of fertilizers in proportion to the amount applied and the differences persisted until harvest. Leaf P and K content was 0.14 and 0.71% respectively before the treatment application. The highest yield was recorded in neem-coated urea treatment, in which the leaf-N content was 2.10%. Chadha *et al.* (2) reported that leaf-N level of 1.89 and 2.03% should be considered optimum for high yield. Increase in P and K was determined after the application of fixed doses of phosphorus and potassium in all the plants, which ranged from 0.17 to 0.2% and 1.15 to 1.50% respectively (Table 3).

SUMMARY

Three levels (200, 400 and 600 g/plant) each of urea, urea supergranule and neem-coated urea were applied on 3-year-old plants of guava cv. Sardar in two equal split doses (i.e. in March and September). Correlation matrix between all possible pairs of vegetative growth characters were worked out. Significant increase in vegetative growth was recorded with 600 g neem-coated urea. As regards yield, 102 fruits in the first year and 125 fruits in the second year, weighing 28.3 kg and 31.9 kg/plant respectively and yield per hectare calculated 7.8 t and 8.8 t/ha, was recorded highest with 600 g neem-coated urea which was significantly higher than with all the other treatments and the control (no fertilizer). Fruit quality was also improved with application of slow-releasing fertilizers. Total soluble solids at 14.8 °Brix and 4.5% reducing sugars were recorded with 600 g neem-coated urea. Maximum ascorbic acid content (326.7 mg/100 g fruit with 600 g urea in the first year and 339.9 mg/100 g fruit) with 600 g neem-coated urea in the second year were observed with 600 g neem-coated urea compared with 258.9 and 237.1 mg/100 fruit in the control. Acidity in fruits was not affected by the different levels and sources of nitrogen. Leaf N increased to 2.11% from 1.77%, and the P and K contents also increased after the application of treatments and fixed doses of P and K.

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