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EFFECT OF NITROGEN, PHOSPHORUS, POTASSIUM AND SULPHUR ON THE YIELD OF MANGO

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Abstract

The experiment was conducted at the research field of Regional Horticulture Research Station, Chapai Nawabganj during 2010-11, 2011-12 and 2012-13 to find out the proper combination of fertilizer nutrients (N, P, K and S) in presence of organic manure for obtaining higher yield of mango (var. BARI Aam-1). The treatments were native nutrient i.e. control (T_1), $N_{360}P_{80}K_{150}S_{50}$ (T_2), $N_{560}P_{120}K_{200}S_{70}$ (T_3), $N_{760}P_{160}K_{250}S_{90}$ (T_4), $N_{960}P_{200}K_{300}S_{110}$ (T_5), and $N_{1100}P_{300}K_{500}S_{120}$ i.e. farmers practice (T_6) g/tree/year. In addition, 20 kg cowdung/tree was used as blanket dose. Number of fruits/tree, individual fruit weight, fruit size, stone weight, peel weight, TSS content and yield of mango varied significantly due to variations of nutrients in all the years. The highest yield and yield attributes were recorded under treatment $N_{960}P_{200}K_{300}S_{110}$ g/tree and it was statistically identical with $N_{760}P_{160}K_{250}S_{90}$ g/tree. The lowest yield was obtained from untreated control plot (native nutrient). The yield benefit for the best treatment (T_5) over the control was 86% in 2010-11, 64% in 2011-12 and 73% in 2012-13. The highest gross margin (Tk 2509/tree in 2010-11, Tk 2651/tree in 2011-12 and Tk 2478/tree in 2012-13) and marginal rate of return (2375% in 2010-11, 2225% in 2011-12 and 2300% in 2012-13) was also obtained from the same treatment. Three years' study revealed that application of $N_{960}P_{200}K_{300}S_{110}$ g/tree along with a blanket dose of 20 kg cowdung/tree appears to be the best treatment and economically optimum for achieving higher yield of mango in Chapai Nawabganj region.

Introduction

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae, originated in South Asia or Malayan archipelago (Mukherjee, 1997). It is lucrative, tasty and rich in vitamins and minerals. Popularly called "King of fruit". In Bangladesh, in terms of total area and production of fruit crops, mango ranks first in area and third in production. It occupies 1.53 lakh hectares of land and total production is 2.99 lakh metric tons per annum with an average yield of 1.95 t/h (BBS, 2012).

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However, the yield of mango is very low compared to that of India, Pakistan and many other mango growing countries in the world (Hossain and Ahmed, 1994). The causes of the low yields are attributed to biotic and abiotic stress and poor nutrient status of the soil as well as use of imbalanced fertilizers. In Bangladesh, most of the farmers do not follow the modern technology of mango cultivation including manuring. However, yield can be increased considerably by adopting judicious nutrient management and high yielding varieties. Application of N, P and K fertilizer to mango tree markedly increased the number of fruit/tree, pulp content as well as fruit quality in India (Satapathy and Banik, 2002). The increased fruit yield due to frequent fertilizer application was also reported by Feungchan *et al.* (1989) and Sharma *et al.* (2002). In Bangladesh, the mango trees mostly in the homestead and the trees in the orchard hardly receive any fertilizer (Hossain, 1989). But systematic research work on the nutritional requirement for mango has been carried out. Therefore, the present investigation was not the proper combination of fertilizer nutrients in presence of organic manure that promotes better yield and quality fruits of mango.

Materials and Method

The experiment was conducted at the research field of Regional Horticulture Research Station, Chapai Nawabganj during 2010-11, 2011-12 and 2012-13. The soil of the experimental field was sandy loam in texture having pH 6.95. Soil samples were collected from the experimental field from a depth of 0-20 cm prior to application of fertilizers in all the years. Results of soil analysis are presented in Table 1. Organic matter content of the soil was very low. Total N, exchangeable Ca, Mn and Zn were found to be below the critical level. Soil Mg, K, P and S contents were at par with critical level while B, Cu and Fe contents were above the critical level.

Table 1. Chemical properties of experimental soil (average of three years).

pH	OM (%)	Ca	Mg	K	Total N (%)	P	S	B	Cu	Fe	Mn	Zn
		meq/100g soil				µg/g						
6.95	0.74	1.53	0.81	0.27	0.037	14.0	14.2	0.78	0.35	20.2	0.79	0.55
Critical level		2.0	0.80	0.20	-	14.0	14.0	0.20	0.10	1.0	5.0	2.0

Six treatments consisted of T_1: native nutrient (control), T_2: $N_{360}P_{80}K_{150}S_{50}$, T_3: $N_{560}P_{120}K_{200}S_{70}$, T_4: $N_{760}P_{160}K_{250}S_{90}$, T_5: $N_{960}P_{200}K_{300}S_{110}$ and T_6: $N_{1100}P_{300}K_{500}S_{120}$ (Farmers practice) g/tree/year. In addition, 20 kg cowdung was used to each tree as blanket dose. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Fertilizers N, P, K and S were applied to the field of mango plant and doses were made constant after 18 years age of the plant as urea, triple superphosphate, muriate of potash and

gypsum, respectively. Full quantity of cowdung was applied to all trees during September. Half of N, P, K and S were applied in mid- September and the remaining quantity was applied in mid- March each year except T_1 and T_6 treatments. In case of treatment T_6, full dose of fertilizers were applied in September. The test variety was BARI Aam-1 (Mahananda). Irrigation, insect and disease control and other intercultural operations were done as and when required. Mature fruits were harvested from first week of June to first week of July during 2011, 2012 and 2013. Fifteen fruits of different sizes and shapes from each tree were randomly selected treatment-wise for data collection. All the data collected on different parameters were analyzed through MSTAT Programme. The Duncan's Multiple Range Test (DMRT) at 5% level of probability used for mean separations of the studied parameters and yield (Gomez and Gomez, 1984).

Results and Discussion

Significant variation in fruits/tree, individual fruit weight, fruit length and diameter were observed due to execution of different treatments (Table 2a). Trees grown with no application of fertilizer produced significantly lower number of fruits/tree compared to others. The maximum number of fruits/tree was found in treatment $N_{960}P_{200}K_{300}S_{110}$ g/tree and it was statistically different from all other treatments irrespective of years. The weight of individual fruit varied significantly with different treatments in all the years. Maximum fruit weight was recorded with the application of $N_{760}P_{160}K_{250}S_{90}$ g/tree in 2010-11 and 2011-13 and it was statistically identical with $N_{960}P_{200}K_{300}S_{110}$ and $N_{1100}P_{300}K_{500}S_{120}$ g/tree treatments. During 2012-13, treatments $N_{560}P_{120}K_{200}S_{70}$ and $N_{1100}P_{300}K_{500}S_{120}$ g/tree gave statistically similar fruit weight, which was significantly different from rest of the treatments. Bhuiyan and Irabagon (1992) also obtained larger and heavier fruits due to the effects of fertilization. The lowest fruit weight was noted in control treatment. Application of fertilizer also increased length of fruit significantly, the highest length being noted with $N_{760}P_{160}K_{250}S_{90}$ g/tree in 2010-11 and it was statistically identical with the treatments $N_{560}P_{120}K_{200}S_{70}$, $N_{960}P_{200}K_{300}S_{110}$ and $N_{1100}P_{300}K_{500}S_{120}$ g/tree. During 2011-12 and 2012-13, longest fruit was recorded with application of $N_{960}P_{200}K_{300}S_{110}$ g/tree followed by that of $N_{560}P_{120}K_{200}S_{70}$ and $N_{760}P_{160}K_{250}S_{90}$ g/tree. Syamal and Mishra (1989) stated that application of fertilizer had markedly influenced the fruit length. The control treatment receiving no fertilizer produced the shortest fruit. The maximum fruit diameter was found in the treatments $N_{760}P_{160}K_{250}S_{90}$ and $N_{960}P_{200}K_{300}S_{110}$ g/tree. These two treatments were significantly different from all other treatments in all the test years. El-Wakeel (2005) indicated that urea at 500 or 1000 g N per tree and potassium sulfate at 400 g K_2O per tree, registered the greatest fruit width in mango (cv. Amrapali) at Dibba Al-Fujira, United Arab Emirates. The minimum fruit diameter was obtained from the control treatment.

Table 2a. Effect of different fertilizer treatments on the number of fruit/tree, individual fruit weight and fruit size (length & diameter) of mango during 2010-11, 2011-12 and 2012-13.

Treatments (g/tree)	Fruits/tree (no.)			Individual fruit weight (g)			Fruit length (cm)			Fruit diameter (cm)		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
Native nutrient (control)	150f	158f	160f	147.9d	172.5b	184.0c	7.01c	7.47d	8.43d	4.48d	5.54b	6.50b
$N_{360}P_{80}K_{150}S_{50}$	180e	183e	186e	172.4c	186.3b	190.3bc	7.55bc	8.23bc	9.19bc	5.10cd	5.57b	6.53b
$N_{560}P_{120}K_{200}S_{70}$	189d	190d	192d	188.5bc	195.6ab	199.6a	7.80abc	8.34abc	9.30abc	5.25cd	6.09b	7.00b
$N_{760}P_{160}K_{250}S_{90}$	226b	228b	230b	215.2a	211.4a	189.0bc	8.65a	8.84ab	9.80ab	6.68a	6.88a	7.84a
$N_{960}P_{200}K_{300}S_{110}$	271a	273a	275a	199.4ab	209.7a	186.0c	8.35ab	8.97a	9.93a	6.05ab	6.91a	7.87a
$N_{1100}P_{300}K_{500}S_{120}$ (Farmers practice)	213c	216c	217c	192.5abc	193.4ab	197.3ab	8.15ab	8.01cd	9.01cd	5.58bc	5.98b	6.94b

Means having same or without letter (s) do not differ significant at 5% level of probability.

Table 2b. Effect of different fertilizer treatments on fruit thickness, stone weight, peel weight and TSS content of mango during 2010-11, 2011-12 and 2012-13.

Treatments (g/tree)	Fruits thickness (cm)			Stone weight (g)			Peel weight (g)			TSS content (%)		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
Native nutrient (control)	5.55	5.60	5.57	26.7d	28.7b	30.7b	26.6c	23.4bc	24.4	14.8c	18.1c	17.1
$N_{360}P_{80}K_{150}S_{50}$	5.86	5.84	5.89	30.6cd	31.2a	33.1a	29.6bc	25.8a	26.8	16.9bc	18.6bc	17.6
$N_{560}P_{120}K_{200}S_{70}$	6.00	6.05	6.04	32.3bc	31.4a	33.4a	30.1bc	24.5ab	25.5	17.8b	20.2a	19.2
$N_{760}P_{160}K_{250}S_{90}$	6.09	6.12	6.18	42.6a	33.8a	35.8a	36.5a	26.5a	27.5	21.5a	20.5a	19.5
$N_{960}P_{200}K_{300}S_{110}$	6.11	6.15	6.20	36.7b	32.7a	34.7a	33.9ab	25.1a	26.1	19.2ab	19.7ab	18.7
$N_{1100}P_{300}K_{500}S_{120}$ (Farmers practice)	5.78	5.80	5.82	33.6bc	31.9a	33.9a	31.3b	23.9b	25.0	18.5b	19.1ab	18.1

Means having same or without letter (s) do not differ significant at 5% level of probability.

The effect of different nutrients (NPK and S) was also significant on stone weight in all the years but peel weight and TSS content in 2010-11 and 2011-12 years only. Fruit thickness due to application of fertilizer did not differ significantly in any of the test years (Table 2b). Maximum weight of stone was recorded with application of $N_{760}P_{160}K_{250}S_{90}$ g/tree treatment, which was significantly different from rest of the treatments in 2010-11. During 2011-12 and 2012-13, maximum weight of stone was found in the treatment $N_{760}P_{160}K_{250}S_{90}$ and it was statistically similar with the treatments $N_{360}P_{80}K_{150}S_{50}$, $N_{560}P_{120}K_{200}S_{70}$, $N_{960}P_{200}K_{300}S_{110}$ and $N_{1100}P_{300}K_{500}S_{120}$ g/tree. Significant increase in weight of peel was also recorded with $N_{760}P_{160}K_{250}S_{90}$ followed by that of treatment $N_{960}P_{200}K_{300}S_{110}$ g/tree. During 2011-1 and 2012-13, maximum peel weight was found in treatment $N_{760}P_{160}K_{250}S_{90}$ g/tree and it was statistically identical with $N_{360}P_{80}K_{150}S_{50}$, $N_{560}P_{120}K_{200}S_{70}$ and $N_{960}P_{200}K_{300}S_{110}$ g/tree treatments. Total soluble sugar (TSS) content of mango showed almost similar trend or response to peel weight.

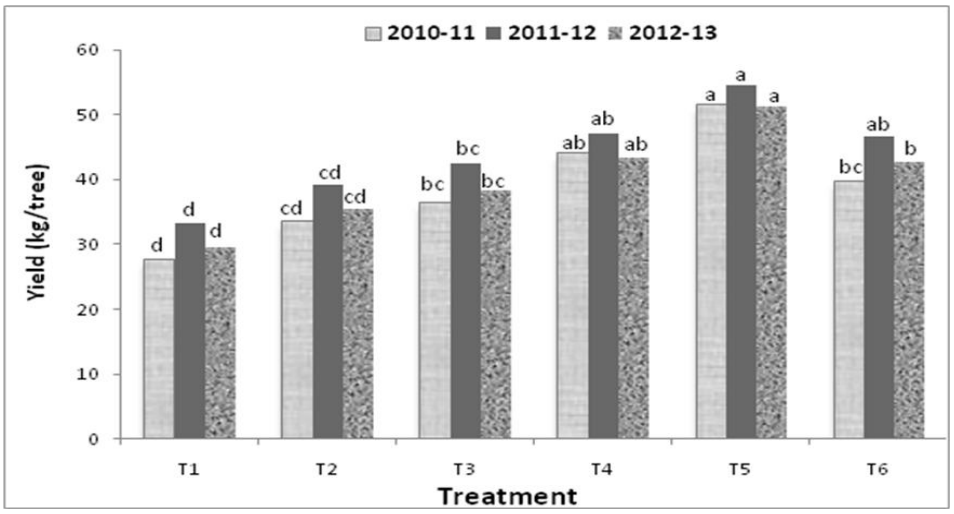

Fig.1. Effect of chemical fertilizer on the yield of mango in 2010-11, 2011-12 and 2012-13 (T_1= Native nutrient i.e. control, T_2= $N_{360}P_{80}K_{150}S_{50}$, T_3= $N_{560}P_{120}K_{200}S_{70}$, T_4= $N_{760}P_{160}K_{250}S_{90}$, T_5= $N_{960}P_{200}K_{300}S_{110}$ and T_6= $N_{1100}P_{300}K_{500}S_{120}$ i.e. farmers practice g/tree/year)

Yield of mango/tree was significantly influenced by different treatment combinations in all the years (Fig.1). Fertilizer application increased yield of mango from 27.79 to 51.78 kg/tree in 2010-2011, 33.30 to 54.61 kg/tree in 2011-2012 and 29.44 to 51.15 kg/tree in 2012-13. Yearly variation in yield of mango/tree was possibly due to climatic factors in different seasons. The highest yield was obtained from the treatments $N_{960}P_{200}K_{300}S_{110}$ g/tree and it was statistically identical with treatment $N_{760}P_{160}K_{250}S_{90}$ g/tree in all the years. These two treatments were significantly better than rest of the treatments. Sharma *et al.*

Table 3. Partial budget and dominance analysis for different fertilizer response data of mango during 2010-11, 2011-12 and 2012-13.

Treatments	Gross return (Tk./tree)			Variable cost (Tk./tree)			Gross margin (Tk./tree)			Remarks		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
T_1	1390	1665	1472	0	0	0	1390	1665	1472	CU	CU	CU
T_2	1682	1961	1770	32	32	32	1650	1929	1738	CU	CU	CU
T_3	1827	2127	1916	48	48	48	1779	2079	1868	CU	CU	CU
T_4	2209	2359	2174	64	64	64	2145	2295	2110	CU	CU	CU
T_5	2589	2731	2558	80	80	80	2509	2651	2478	CU	CU	CU
T_6	1990	2336	2141	104	104	104	1886	2232	2037	CD	CD	CD

(T_1= Native nutrient i.e. control, T_2= $N_{360}P_{80}K_{150}S_{50}$, T_3= $N_{560}P_{120}K_{200}S_{70,}$ T_4= $N_{760}P_{160}K_{250}S_{90}$, T_5= $N_{960}P_{200}K_{300}S_{110}$ andT_6= $N_{1100}P_{300}K_{500}S_{120}$

i.e. farmers practice g/tree/year)

Table 4. Marginal analysis of un-dominated fertilizer response data of mango during 2010-11, 2011-12 and 2012-13.

Treat-ments	Gross margin (Tk./tree)			Variable cost (Tk./tree)			Marginal increase in gross margin (Tk./tree)			Marginal increase in variable cost (Tk./ha)			Marginal rate of return (%)		
	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13	2010-11	2011-12	2012-13
T_5	2509	2651	2478	80	80	80	380	356	368	16	16	16	2375	2225	2300
T_4	2129	2295	2110	64	64	64	350	216	242	16	16	16	2188	1350	1513
T_3	1779	2079	1868	48	48	48	129	150	130	16	16	16	806	938	813
T_2	1650	1929	1738	32	32	32	260	264	266	32	32	32	813	825	831
T_1	1390	1665	1472	0	0	0	-	-	-	-	-	-	-	-	-

(2000) reported that application of 800 g N + 200 g P + 300 g K significantly increased the yield/tree of mango. Suryapananont (1992) also obtained highest yield with 0.5 kg N + 0.4 kg P + 1.5 kg K/tree in mango. Hossain (1989) reported that application of cowdung 25 kg + urea 750 g + TSP 400 g + MoP 250 g + gypsum 250 g + zinc sulphate 15 g/tree increased the yield of mango. Satapathy and Banik (2002) who opined that application of N, P, and K per mango plant cv. Amrapali per year in West Bengal, India, markedly increased the yield/plant as well as fruit quality.

The maximum yield/tree was produced by $N_{960}P_{200}K_{300}S_{110}$ and $N_{760}P_{160}K_{250}S_{90}$ treatments perhaps supply of sufficient amount of nutrients necessary for better growth and plant development had resulted in higher fruit set and weight. Farmers practice ($N_{1100}P_{300}K_{500}S_{120}$ g/tree) caused a remarkable reduction in yield of mango by 23% in 2010-11, 15% in 2011-12 and 16% in 2012-13 over treatment $N_{960}P_{200}K_{300}S_{110}$ g/tree. It indicated that higher fertilizer levels possibly produced some barrier on nutrition of mango plant or prevalence of other constraints in soil and hence reduced the yield. Plants grown without (native nutrient) added or lower fertilizer produced the lowest yield/tree irrespective of years.

Economic evaluation

Gross return was calculated from the price of mango. Costs that vary were calculated from the cost involved for fertilizer used for the experimental treatments. The partial budget analysis of fertilizer revealed that the maximum gross margin/tree was achieved with the treatment combination $N_{960}P_{200}K_{300}S_{110}$ in all the years (Table 3). Dominance analysis shows that treatments $N_{1100}P_{300}K_{500}S_{120}$ was cost dominated irrespective of years. Marginal analysis shows that the highest marginal rate of return of 2375% in 2010-11, 2225% in 2011-12 and 2300% in 2012-13 was obtained when the crop was fertilized with $N_{960}P_{200}K_{300}S_{110}$ treatment (Table 4). Hence, application of fertilizer at the rate of $N_{960}P_{200}K_{300}S_{110}$ g/tree would be economical for better mango production.

Conclusion

Three years' study revealed that application of $N_{960}P_{200}K_{300}S_{110}$ g/tree along with a blanket dose of 20 kg cowdung/tree is economically optimum for maximizing the yield of mango in Chapai Nawabgonj regions.

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