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Study the effect of split application of fertilizers on yield and quality of alphonso mango (*Mangifera indica* L.) in lateritic soil

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Abstract

An investigation on “Effect of split application of fertilizers on soil properties, leaf nutrient content, yield and quality of Alphonso mango (*Mangifera indica* L.) in lateritic soil.” was undertaken at research Farm of Horticulture, Plot No. 14, College of Horticulture, Dapoli during the year 2021-22 and 2022-2023. The experiment was conducted in Randomised Block Design (RBD) with nine treatment of split nutrient application, three replication and two plant served as a treatment unit (plant/replication). Significantly graded increase in the number of fruits per tree, average weight of fruit, fruit yield kg per tree and yield of mango ton per hectare with the graded doses of fertilizers (i.e. N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/ plant, 3.0:1.0:2.0 kg/ plant and 4.5:1.5:3.0 kg/ plant), where treatment T₆ (i.e. N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + 1% KNO₃ foliar spray at pea nut, marble and egg stage) recorded the significantly highest value. There was graded increase in total soluble solids, B-carotene, ascorbic acid, reducing sugar and total sugar with the graded doses of fertilizers i.e. N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/ plant, 3.0:1.0:2.0 kg/ plant and 4.5:1.5:3.0 kg/ plant, where treatment T₆ (i.e. N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + 1% KNO₃ foliar spray at pea nut, marble and egg stage) recorded the significantly highest value.

Keywords: Alphonso mango, split fertilizer application, lateritic soil, nutrient management, fruit yield, fruit quality

Introduction

Mango (*Mangifera India* L.) also referred as “The king of the fruits” is the most important commercially grown fruit crop of Indian Subcontinent. ‘Alphonso’ is acclaimed as one of the best among the various commercial varieties of mango grown in the country. This variety is majorly grown in Ratnagiri and Sindhudurg district of the Maharashtra state. Due to Unique characteristics like sugar-acid blend, attractive color, shape, pleasant aroma, highly appreciable flavor and taste Alphonso enjoy virtual dominance both in domestic as well as international market. India is the largest producer of Mango in the world, and ranks first in the area and production. The total production of mango in India is 20.872 MT from about 2.346 million ha area with the productivity of 8.91 MT ha (Anonymous, 2024) ^[1]. In Maharashtra, Mango is occupying an area of 0.170 million ha with annual production of 0.801 million ton with productivity of 1.3 MT ha⁻¹. In Konkan, 2 lakh HA productive area was under mango cultivation having annual production of 2.80 lakh MT. The productivity of mango in Konkan is about 2.5 to 3.0 MT ha⁻¹, which is about three times less than the average productivity of the country (Anonymous, 2024) ^[1]. The low productivity and yield fluctuation of the Alphonso mango in Konkan region has several reasons of which the fertility status of the soil is one of the most important factors. In addition, inadequate use of manures and fertilizers along with imbalance of nutrients are also responsible for low yield. The uncertain environment is another factor influencing the yield of Alphonso. The alternate bearing tendency of Alphonso mango adds severity to the yield fluctuation although they show a wide span of bearing. Variation in production efficiency of mango orchards can be partially attributed to variations in soil and leaf

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nutrients. Improper management practices which include under nutrition and negligence of orchards also affect the yield. The yield and quality of mango are dependent on adequacy and balance of plant nutrient elements in the trees before bearing and harvest. In addition, there is a heavy nutrient loss of some of the macro and micronutrients, possibly due to heavy rainfall and undulating terrain (Pereira *et al.*, 1986)^[10].

In the past, researchers have paid more attention on the use of proper amount of fertilizer to increase the yields in mango, but very little work has been done on the split and continuous application of fertilizers on regular basis. The present study was therefore undertaken to find out the effects of fertilizer and its installment of application at different stages of plant growth on yield and quality of mango

Materials and Methods

An investigation on “Effect of split application of fertilizers on soil properties, leaf nutrient content, yield and quality of Alphonso mango (*Mangifera indica* L.) in lateritic soil. ” was undertaken at research Farm of Horticulture, Plot No. 14, College of Horticulture, Dapoli during the year 2021-22 and 2022-2023. The field experiment was laid out in Randomized Block Design with three replications and nine treatments comprising of (T₁) (N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/ plant during 1st fortnight of June + 1% KNO₃ foliar spray at peanut, marble and egg stage), (T₂)(N:P₂O₅:K₂O @ 3.0:1.0:2.0 kg/ plant during 1st fortnight of June + 1% KNO₃ foliar spray at peanut, marble and egg stage),(T₃)N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/ plant during 1st fortnight of June + 1% KNO₃ foliar spray at peanut, marble and egg stage.(T₄)N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/ plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + 1% KNO₃ foliar spray at pea nut, marble and egg stage.T₅N:P₂O₅:K₂O @ 3.0:1.0:2.0 kg/ plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + @ 1% KNO₃ foliar spray at pea nut, marble and egg stageb T₆N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + 1% KNO₃ foliar spray at pea nut, marble and egg stage.T₇N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + Amrashakti Multi-nutrient Spray @ 1% at bud break, full bloom inflorescences and egg size fruit.T₈N:P₂O₅:K₂O @ 3.0:1.0:2.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + Amrashakti Multi-nutrient Spray @ 1% at bud break, full bloom

inflorescences and egg size fruit.T₉ N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + Amrashakti Multi-nutrient Spray @ 1% before flowering, at bud break, full bloom inflorescences and egg size fruit.

The green fresh fruits weight was taken immediately after harvest of fruits. The fruits from observational tree were picked and counted at each picking. Numbers of harvested fruits trees⁻¹ were counted and their total weight in kilograms(kg)per tree was recorded and calculated on the basis of yield ha⁻¹, T.S.S. was determined by Hand Refractometer and Titratable acidity was estimated by Titration with NaOH as per the procedure given by A.O.A.C.(1975)^[12].Ascorbic acid in mango fruit was determined by 2,6,dichlorophenol indophenols dye method while, Reducing and Non reducing sugar was estimated by Lane and Eynon method and Beta-carotene was determined colorimetrically as described by Ranganna (1997)^[12].

Results and Discussion

1. Number of fruits per tree

The perusal of the data (Table 1) indicated that there was graded increase in number of fruits per tree with the graded doses of fertilizers from 1.5:0.5:1.0 to 4.5:1.5:3.0 kg plant⁻¹ N:P₂O₅:K₂O with 1% KNO₃ sole (T₁ to T₃) or with 1% KNO₃ + soil application of Zn, Cu and B (T₄ to T₆) or with Amrashakti multi-nutrient spray sole (T₇ to T₉), where the highest dose of fertilizers (i.e. 4.5:1.5:3.0 kg/plant N:P₂O₅:K₂O) recorded the higher values of number of fruits per tree either with foliar spray of 1% KNO₃ or Amrashakti multi-nutrient spray or soil application of Zn, Cu and B. Application of N:P₂O₅:K₂O @ 4.5:1.5:3.0 kgplant⁻¹ in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg ha⁻¹ + KNO₃ @ 1% at pea nut, marble and egg stage (treatment T₆) exhibited the significantly highest number of fruits per tree i.e. 239.29 fruits tree⁻¹ during first year and 255.23 fruits tree⁻¹ during second year, which was at par with T₉, T₅ and T₈ during both the years of experimentation. Among others, treatment T₄ and T₃ during first year and T₄, T₃ and T₇ during second year were at par. The lowest number of fruits per tree T₁ (136.85 fruits tree⁻¹ during 2021-22 and 138.63 fruits tree⁻¹ during 2022-23) was observed with the application of N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg plant⁻¹ during 1st fortnight of June + 1% KNO₃ foliar spray at peanut, marble and egg stage during both the years.Patil (2017)^[16] also observed that the application of recommended dose + 100 per cent extra recommended dose significantly yielded highest number of fruits (320 tree⁻¹).

Table 1: Effect of split application of fertilizers on number of fruits, average weight and yield of Alphonso mango

Treat. No.	2021-22				2022-23			
	No. of fruits (tree ⁻¹)	Average wt. of fruit (g)	Yield (kg tree ⁻¹)	Yield (t ha ⁻¹)	No. of fruits (tree ⁻¹)	Average wt. of fruit (g)	Yield (kg tree ⁻¹)	Yield (t ha ⁻¹)
T ₁	136.85	224.09	30.74	3.07	138.63	235.93	32.71	3.27
T ₂	151.33	234.43	35.32	3.53	152.31	237.91	36.21	3.62
T ₃	180.76	243.83	44.03	4.40	176.77	251.42	44.37	4.44
T ₄	208.00	244.15	50.76	5.08	213.00	259.17	55.10	5.51
T ₅	218.95	264.52	57.91	5.79	242.02	264.87	64.09	6.41
T ₆	239.29	267.71	64.07	6.41	255.23	273.58	69.84	6.98
T ₇	169.87	242.08	41.10	4.11	173.78	258.07	44.83	4.48
T ₈	214.27	260.85	55.88	5.59	219.27	271.47	59.07	5.91
T ₉	238.26	263.42	62.78	6.28	245.20	274.61	67.35	6.74
S.E.(m)±	9.65	6.42	8.86	0.25	13.81	6.07	3.08	0.31
C.D.(P=0.05)	28.94	19.25	26.56	0.75	41.41	18.19	9.24	0.92

The perusal of data indicated that there was an increase in fruit yield of mango with the split application of fertilizers (in treatments T₄ to T₉) over its single application (T₁, T₂ and T₃). Increase in fruit yield of mango with increase in split application of fertilizers in the current study are close to the findings of Jain (2019)^[5] and Pawar (2023)^[17] in sapota in lateritic soils of Konkan, where increasing doses of fertilizers were applied in one, two and three splits.

The results of the present study indicated as it is, essential that mango trees are supplied with suitable and adequate nutrients for ensuring its sustained productivity and their requirement has to be supplied through external sources in order to avoid any yield loss.

2. Average weight of fruit

The data regarding split applications of NPK (Table 1) with foliar spray of 1% KNO₃ or Amrashakti multi-nutrient spray or soil application of Zn, Cu and B significantly influence the average weight of fruit, which varied from 224.09 to 267.71 kg during first year and 235.93 to 273.58 kg during second year are presented in (Table 1). It was revealed from the data that application of N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/ plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage (treatment T₆) exhibited the significantly highest average wt. of fruit per tree i.e. 267.71 kg tree⁻¹ during first year and 273.58 kg tree⁻¹ during second year, which was at par with T₉, T₅ and T₈ during first years and T₄, T₅, T₇, T₈ and T₉ during second year experimentation. Among others, treatment T₄ and T₃ during first year and T₄, T₃ and T₇ during second year were at par. The lowest average wt. of fruit per tree (224.09 kg tree⁻¹ during first year and 235.93 kg tree⁻¹ during second year) was observed with the application of N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/plant during 1st fortnight of June + 1% KNO₃ foliar spray at peanut, marble and egg stage (T₁) during both the years. Increase in fruit yield of sapota with increase in split application of fertilizers in the current study are close to the findings of Jain (2019)^[5] and Pawar (2023)^[17] in sapota in lateritic soils of Konkan, where increasing doses of fertilizers were applied in one, two and three splits.

3. Yield of mango kg tree⁻¹

It was revealed from (Table 1) the data application of N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/ plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage (treatment T₆) exhibited the significantly highest yield kg per tree i.e. 64.07 kg tree⁻¹ during first year and 69.84 kg tree⁻¹ during second year, which was at par with T₄, T₅, T₇, T₈ and T₉ during first years and T₅ and T₉ during second year experimentation. Patil (2017)^[16] also observed the application of recommended dose+100 percent extra recommended dose significantly produced highest yield (98.89 and 90.43 kg tree⁻¹). The lowest average wt. of fruit per tree (30.74 kg tree⁻¹ during first year and 32.71 kg tree⁻¹ during

second year) was observed with the application of N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/plant during 1st fortnight of June + 1% KNO₃ foliar spray at peanut, marble and egg stage (T₁) during both the years. Increase in fruit yield of mango kg per tree with increase in split application of fertilizers in the current study are close to the findings of Jain (2019)^[5] and Pawar (2023)^[17] in sapota in lateritic soils of Konkan, where increasing doses of fertilizers were applied in one, two and three splits.

Increase in the increase in yield kg per tree might be due to optimum supply of plant nutrients through application of NPK in two or three splits with or without Zn + B along with vermicompost in desired amount during the fruit growth period resulting in accumulation of more photosynthates leading to increase in fruit yield.

4. Yield of mango t ha⁻¹

It is evident from data presented in Table 1 that application of N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage (treatment T₆) exhibited the significantly highest yield of mango ton per hectare i.e. 6.41 t ha⁻¹ during first years and 6.98 t ha⁻¹ during second year which was found to be at par with T₅, T₈ and T₉ during first year and T₅ and T₈ during second year. The lowest number of fruits per tree 3.07 t ha⁻¹ during first year and 3.27 t ha⁻¹ during second year was observed with the application of N:P₂O₅:K₂O @ 1.5:0.5:1.0 kg/plant during 1st fortnight of June + 1% KNO₃ foliar spray at peanut, marble and egg stage (T₁) during both the years.

Shinde *et al.* (2009)^[14] found that the application of potassium in soil and its foliar spray for Alphonso mango at Wakavali significantly increased the yield from 42.86 to 83.40 kg tree⁻¹. Dabke found that the soil application of N, P, K and 1% foliar sprays of KNO₃ produced significantly more fruit yield (78.57 kg tree⁻¹) over control (40.04 kg tree⁻¹) in Alphonso mango.

Possible explanation for increase in yield with Zn and B application could be attributed to the fact that Zn is an essential element required by plants for different metabolic process and play vital part in enzyme activation and biosynthesis of specific growth hormones (Noor and Tariq, 2019)^[9].

5. Total Soluble Solids (TSS)

The data presented in table 2 revealed that treatment T₆ (N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg plant⁻¹ in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage) exhibited the significantly maximum total soluble solid (19.05 °Brix and 19.60 °Brix during first year and second year, respectively), which was at par with T₉ during first year and with T₉, T₈ T₅ and T₄ treatments during second year. Thus, the result of present investigation indicated the significant combined effect of fertilizer doses and installment of application on TSS. Similarly range of TSS in mango fruits were also reported by Puranik (2015)^[11], Jadhav *et al.* (2019)^[4] and Dheware *et al.* (2020)^[3].

Table 2: Effect of split application of fertilizer on quality of Alphonso mango

Treat. No.	2021-22			2022-23		
	Total Soluble Sugar (^o Brix)	Acidity (%)	B-carotene (mg100 g ⁻¹)	Total Soluble Sugar (^o Brix)	Acidity (%)	β-carotene (mg 100 g ⁻¹)
T ₁	15.24	0.319	8.89	15.33	0.325	9.21
T ₂	16.19	0.303	9.67	16.55	0.309	9.31
T ₃	16.77	0.290	10.65	17.94	0.288	10.13
T ₄	16.60	0.310	10.74	18.41	0.298	10.96
T ₅	18.04	0.293	11.84	18.64	0.301	11.88
T ₆	19.05	0.269	12.03	19.60	0.267	12.07
T ₇	16.72	0.304	10.67	16.62	0.313	10.74
T ₈	18.20	0.289	11.72	18.62	0.303	11.79
T ₉	18.91	0.274	11.93	19.09	0.277	11.96
S.E.(m)±	0.44	0.006	0.39	0.51	0.00	0.28
C.D.(P=0.05)	1.308	0.018	1.158	1.518	0.018	0.849

Similar trend of increase in TSS with the graded doses of fertilizers in different splits were also reported by Sarker and Rahim (2012) ^[13] in their study on effects of doses and splits of fertilizer application on yield and quality of mango cv. Amrapali. Puranik (2015) ^[11] also reported increase in TSS with the graded doses of fertilizers through briquettes in lateritic soils of Konkan. The increase in TSS may be due to the combined effect of nutrients that enhanced the conversion of complex polysaccharides into simple sugar through translocation of sugars from leaves to developing fruits (Jadhav *et al.*, 2019) ^[4].

6. Titratable Acidity

The perusal of the data (Table 2) indicated that treatment T₆ (N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg plant⁻¹ in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage) exhibited the significantly minimum titratable acidity (0.269 to and 0.267 mg 100 g⁻¹ during first year and second year, respectively), which was at par with T₉ treatments during both the years. Thus, the result of present investigation indicated the significant combined effect of fertilizer doses and installment of application on titratable acidity. Significantly maximum titratable acidity (0.319 mg 100 g⁻¹ during first year and 0.325 mg 100 g⁻¹ during second year) was recorded with treatment T₁.

Similar values of titratable acidity were reported by Patil *et al.* (2010) ^[16], who reported the treatment receiving foliar spray of 0.5 per cent urea, sulphate of potash and single super phosphate each + 0.25 per cent zinc sulphate, copper sulphate and borax each + 0.01 per cent ammonium molybdate recorded significantly minimum titratable acidity in Alphonso mango.

The lowest acidity by application of nutrients combination may be due to conversion of acid into sugar and their derivatives by the reaction involving reversal glycolytic pathway. The enhancement in quality of fruit could be due to the catalytic action of micronutrients particularly at higher concentration. Hence, the foliar spray of micronutrients quickly increased the uptake of macronutrients in the tissues and organs of the mango plants, decreased the nutritional deficiencies and improved the fruit quality.

7. β-carotene (mg 100 g⁻¹)

The data regarding β-carotene content (Table 2) in mango fruit as affected by Split applications of NPK with foliar spray of 1% KNO₃ or Amrashakti multi-nutrient spray or soil application of Zn, Cu and B significantly influenced the β-carotene which ranged from 8.89 to 12.03 mg 100 g⁻¹ and 9.21 to 12.07 mg 100 g⁻¹ during first year and second year, respectively (Table 32). The

perusal of the data indicated that treatment T₆ (N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage) exhibited the significantly maximum β-carotene (12.03 mg 100 g⁻¹ and 12.07 mg 100 g⁻¹ during first year and second year, respectively), which was at par with T₈, T₅ and T₉ during both the years. Thus, the result of present investigation indicated the significant combined effect of fertilizer doses and installment of application on β-carotene. Minimum β-carotene was recorded with treatment T₁ (8.89 mg 100 g⁻¹ during first year and 9.21 mg 100 g⁻¹ during second year). Similar trend of increase in B-carotene with the graded doses of fertilizers in different splits were also reported by Sarker and Rahim (2012) ^[13] in their study on effects of doses and splits of fertilizer application on yield and quality of mango cv. Amrapali. Puranik (2015) ^[11] also reported increase in B-carotene with the graded doses of fertilizers through briquettes in lateritic soils of Konkan.

8. Ascorbic acid

From the data presented in Table -3, it was evident that ascorbic acid content varied significantly from 35.76 to 45.02 mg 100 g⁻¹ and 34.76 to 48.68 mg 100 g⁻¹ during first year and second year, respectively. The treatment T₆ (N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage) exhibited the significantly maximum ascorbic acid (45.02 to and 48.68 mg 100 g⁻¹ during first year and second year, respectively), which was at par with T₅, T₈ and T₉ treatments during first year and with T₅ and T₉ treatments during second year. Thus, the result of present investigation indicated the significant combined effect of fertilizer doses and installment of application on ascorbic acid. Minimum ascorbic acid of 35.76 mg 100 g⁻¹ during first year and 34.52 mg 100 g⁻¹ during second year was recorded with treatment T₁. Similar trend of increase in ascorbic acid with the graded doses of fertilizers in different splits were also reported by Sarker and Rahim (2012) ^[13] in their study on effects of doses and splits of fertilizer application on harvesting time, yield and quality of mango cv. Amrapali. In lateritic soils of Konkan, Puranik (2015) ^[11] also observed increase in ascorbic acid with the graded doses of fertilizers through briquettes, where application of FYM @ 50 kg tree⁻¹ + RDF + copper through copper sulphate @ 15 kg ha⁻¹ + boron through borax @ 10 kg ha⁻¹ + molybdenum through sodium molybdate @ 0.250 kg ha⁻¹ increased ascorbic acid which was significantly superior over all the treatments.

Similarly range of ascorbic acid in mango fruits were also reported by More (2013) ^[18], Puranik (2015) ^[11], Jadhav *et al.* (2019) ^[4] and Dheware *et al.* (2020) ^[3].

9. Reducing Sugar

Split applications of NPK with foliar spray of 1% KNO₃ or Amrashakti multi-nutrient spray or soil application of Zn, Cu

and B significantly influenced (Table 3) the reducing sugars which ranged from 3.19 to 2.46 and 3.32 to 2.64 during first and second year, respectively (Table 33). Similarly range of reducing sugars in mango fruits were also reported by Joshi and Roy (1985) ^[15], Puranik (2015) ^[11], Jadhav *et al.* (2019) ^[4] and Dheware *et al.* (2020) ^[3].

Table 3: Effect of split application of fertilizers on quality of Alphonso mango

Treat. No.	2021-22				2022-23			
	Ascorbic acid (mg100 g ⁻¹)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Ascorbic acid (mg100 g ⁻¹)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
T ₁	35.76	2.46	8.13	10.60	34.52	2.64	8.96	11.60
T ₂	36.74	2.56	9.18	11.74	35.07	2.67	9.34	12.02
T ₃	38.05	2.57	9.42	11.99	38.39	2.81	9.80	12.61
T ₄	39.96	2.45	10.05	12.50	40.29	2.96	9.96	12.92
T ₅	43.31	3.09	10.23	13.32	44.98	3.15	10.35	13.50
T ₆	45.02	3.19	10.38	13.57	48.68	3.32	10.34	13.66
T ₇	39.89	2.86	9.28	12.14	39.56	3.14	9.58	13.02
T ₈	41.91	3.16	10.16	13.31	43.25	3.27	10.10	13.37
T ₉	44.60	3.10	10.32	13.42	46.60	3.19	10.31	13.50
S.E.(m)±	1.24	0.17	0.31	0.28	1.45	0.06	0.12	0.15
C.D.(P=0.05)	3.709	0.514	0.929	0.826	4.334	0.186	0.361	0.449

The data indicated that treatment T₆ (N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage) exhibited the significantly maximum reducing sugars (3.19 and 3.32 during first year and second year, respectively), which was at par with T₅, T₇, T₈ and T₉ treatments during both the years. Thus, the result of present investigation indicated the significant combined effect of fertilizer doses and installment of application on reducing sugars.

Similar trend of increase in reducing sugars with the graded doses of fertilizers (i.e. 50%, 100% and 150% RDF) in one, two and three splits were also reported by Sarker and Rahim (2012) ^[13] in their study on effects of doses and splits of fertilizer application on harvesting time, yield and quality of mango cv. Amrapali, where 150% RDF with three splits noted the higher value. Increase in reducing sugars in alphonso mango with the graded doses of fertilizers through briquettes in lateritic soils of Konkan with application of FYM @ 50 kg tree⁻¹ + RDF + copper through copper sulphate @ 15 kg ha⁻¹ + boron through borax @ 10 kg ha⁻¹ + molybdenum through sodium molybdate @ 0.250 kg ha⁻¹ were observed by Puranik (2015) ^[11].

In this regards, Dheware *et al.* (2020) ^[3] explained the enhancement in quality of fruit could be due to the catalytic action of micronutrients particularly at higher concentration. Hence, the foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs of the mango plants, decreased the nutritional deficiencies and improved the fruit quality.

10. Non-reducing Sugar

The perusal of the data (Table 3) indicated that treatment T₆ (N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage) exhibited the significantly maximum non-reducing sugars (10.38 and 10.34 per cent during first and second year, respectively), which was at par with T₄, T₅, T₈ and T₉ during first year and with T₅, T₈ and T₉ treatments during second year. Thus, the result of present

investigation indicated the significant combined effect of fertilizer doses and installment of application on non-reducing sugars. Similarly range of non-reducing sugars in mango fruits were also reported by Joshi and Roy (1985) ^[15], Gole (1985), Puranik (2015) ^[11], Jadhav *et al.* (2019) ^[4] and Dheware *et al.* (2020) ^[3].

The increase in non-reducing sugars may be due to the combine effect of nutrients that enhanced the conversion of complex polysaccharides into simple sugar through translocation of sugars from leaves to developing fruits (Jadhav *et al.*, 2019) ^[4]. The enhancement in quality of fruit could be due to the catalytic action of micronutrients particularly at higher concentration. Hence, the foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs of the mango plants, decreased the nutritional deficiencies and improved the fruit quality (Dheware *et al.*, 2020) ^[3].

11. Total Sugar

The perusal of the data (Table 3) indicated that treatment T₆ (N:P₂O₅:K₂O @ 4.5:1.5:3.0 kg/plant in two equal splits, first during 1st fortnight of June and second at the end of September + micronutrient mixture Zn and Cu @ 15 kg/ha, B @ 10 kg/ha + KNO₃ @ 1% at pea nut, marble and egg stage) exhibited the significantly maximum total sugars (13.57 and 13.66 during first and second year, respectively), which was at par with T₅, T₈ and T₉ during both the years. Thus, the result of present investigation indicated the significant combined effect of fertilizer doses and installment of application on total sugars.

Manjrekar (2000) ^[8] noted that the trees supplied with higher potash along with recommended dose of N and P recorded highest T.S.S. (18.73 °Brix), which was significantly superior over absolute control. Malhi (1982) ^[6] and Malhi *et al.* (1988) ^[7] reported that the higher level of N and P (300g and 87.4g) which significantly increased the T.S.S. in comparison with the other levels of N and P.

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