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Effect of chemical fertilizer application in split on yield of hybrid coconut cv. TXD (Mahuva)

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Abstract
A field experiment was conducted at Agriculture Research Station (Fruit Crops), Junagadh Agricultural University, Mahuva to assess the "Effect of chemical fertilizer application on hybrid coconut cv. TxD (Mahuva)" during 2014-15 to 2016-17. The experiment was conducted to evaluate two factors with three levels each. Among the two factor, one was dose of fertilizers *viz.*, D_1: 100% RDF NPK @ 1500, 750, 1500 g/palm/year, D_2: 125% RDF NPK @ 1875, 938, 1875 g/palm/year, D_3: 150% RDF NPK @ 2250, 1125, 2250 g/palm/year and second factor as number of splits of fertilizers *viz.*, S_1: Two split [June-Oct. (Control)], S_2: Three Split (June-Oct.-Feb.), S_3: Four Split (June-Aug.-Nov.-Feb.). The experiment was laid out in randomized block design with factorial concept (FRBD) with three replications. Total two palm of hybrid coconut cv. TxD (Mahuva) taken in each treatments. The results obtained from the present investigation, revealed that the application of higher dose of chemical fertilizer i.e. 125% or 150% in four equal splits obtained significantly higher nut length as well as nut yield. As the coconut palm is perennial and producing nuts round the year the application of chemical fertilizers in four splits supply nutrients to the palm all the year results in positive impact on yield of nuts.

Keywords: Hybrid coconut, fertilizer levels, nutrient management, split application, nut yield, Mahuva

Introduction
The coconut palm (*Cocos nucifera* L.) belongs to the palm family (Arecaceae) is the most useful palm in the world. Every part of the tree is useful to human life for some purpose or the other. Hence, the coconut palm is endearingly called '*Kalpa vriksha*' meaning the tree of heaven. The copra obtained by drying the kernel of coconut is the richest sources of vegetable oil containing 65 to 70 per cent oil.

The coconut palm is suitable to grow under varying climatic and soil conditions. It is essentially a tropical plant growing mostly between 20° N and 20° S latitudes. However, a well distributed rainfall of about 2000 mm/year is ideal for proper growth and maximum production. Coconut is grown under different soil types such as loamy, laterite, coastal sandy, alluvial, clayey and reclaimed soils of the marshy low lands. The ideal soil conditions for better growth and performance of the palm are proper drainage, good water-holding capacity and presence of water table within 3 m and absence of rock or any hard substratum within 2 m of the surface.

The coconut palm continues to yield more than over 80 years. Coconut is currently grown in more than 90 countries spread along the tropical belt of 12.26 million hectares (Anon., 2021) [2] in the world (Fig. 1.1), eight million hectares, or about 70% is in South East & East Asia (Carpio, *et al.*, 2005) [4]. India occupied an area of 2.28 million hectares with an annual production of 20535.88 million nuts as per an estimate (All India final estimates) of 2022-23 (Anon., 2023). Cultivation of coconut in India is restricted to fifteen states/Union Territories and most of these are located on coastal belts or sea shore. Among the various states/Union Territories, Kerala and Karnataka ranks first and second in area respectively and Karnataka and Kerala ranks first and second in production respectively, whereas Gujarat stands at 8th position in area (24,780 ha) and 7th position in production (211.33 million nuts).

In order to attain self-sufficiency for coconut and its byproduct, it is necessary to improve and increase the production. This can be achieved either by increasing the production per unit area or by increasing the existing area under coconut crop through new planting. The solution to the problem on a long-term basis lies in extending the area under coconut and also replacing the old and uneconomic trees in the existing gardens by planting vigorous seedlings of new improved cultivars of coconut (Kutty, 1955) [5].

Balanced nutrition is a pre-requisite for proper growth of plant, yield and quality of produce. This is indispensable especially in fruit and plantation crops like coconut as they are perennial in nature. Coconut is an important crop of coastal region of Saurashtra. Old information and recommendations on nutritional aspect for this were available for South Gujarat conditions but it was scanty especially for varieties released in Saurashtra region. Further it was also necessary to re-test the nutritional need of the plant in present conditions as many climatic changes has been taken place in last decades. Apart from this, meeting the crop needs at the same time as maintaining and improving native soil fertility and productivity of today's needs and is of great importance. Optimal and consistent fertilization significantly increases coconut yield, but the effect of a specific dose varies based on the tree's age, the method of application, soil conditions, and the nutrients included.

There were very little findings available about the use of fertilizer application in more than 2 splits, especially in hybrid coconut variety TxD (Mahuva). Keeping these views in mind this research trial was carried out with the objective to find out optimum dose and split of chemical fertilizer for coconut cv. TxD (Mahuva).

Materials and Methods

The present trial was taken up at Agricultural Research Station (Fruit Crops), Junagadh Agricultural University, Mahuva, Dist. Bhavnagar, Gujarat, India during the year 2013-14 to 2016-17. The coconut variety under investigation was TxD (Mahuva) and with 25 years old palm were selected for the study.

The experiment was set up using Randomized Block Design with a Factorial concept (FRBD), involving two factors and nine treatment combinations. The first factor as dose of fertilizers *viz.*, D_1: 100% RDF NPK @ 1500, 750, 1500 g/palm/year, D_2: 125% RDF NPK @ 1875, 938, 1875 g/palm/year, D_3: 150% RDF NPK @ 2250, 1125, 2250 g/palm/year and second factor as number of splits of fertilizers *viz.*, S_1: Two split [June-Oct. (Control)], S_2: Three Split (June-Oct.-Feb.), S_3: Four Split (June-Aug.-Nov.-Feb.). The different treatment combinations are as follow (1) D_1S_1 (2) D_1S_2 (3) D_1S_3 (4) D_2S_1 (5) D_2S_2 (6) D_2S_3 (7) D_3S_1 (8) D_3S_2 (9) D_3S_3. The uniform application of 50 kg FYM/palm/year followed in each treatment combination. The treatments replicated for three times. There were two palm taken per treatment. The all other cultural practices performed as per recommendation and requirements.

Soil analysis was carried out before and at the end of the experiment to assess the fertility status of the soil. The observations related to nut yield and yield attributes like nut length, nut girth, and nut water content were noted every year for coconut fruits.

Results and Discussion

The outcomes of different treatments were documented and the results obtained during the investigation were thoroughly discussed, supported by reasoning and relevant references. The data recorded regarding nut yield and yield attributes are presented in Table 1 to Table 4.

The results of different treatments on nut length of coconut cv. TxD (Mahuva) was presented in table 1.

Table 1: Effect of different treatments on nut length of coconut TxD (Mahuva)

Treatment	Nut length of coconut (cm)			
	2014-15	2015-16	2016-17	Pooled
D (Factor A)				
D_1	21.87	22.13	22.65	22.22
D_2	24.26	24.59	25.11	24.65
D_3	26.09	26.26	26.80	26.39
S.Em.±	0.84	0.87	0.87	0.50
C.D. at 5%	2.53	2.63	2.60	1.42
S (Factor B)				
S_1	23.08	23.29	23.80	23.39
S_2	24.12	24.42	24.93	24.49
S_3	25.02	25.27	25.83	25.37
S.Em.±	0.84	0.87	0.87	0.50
C.D. at 5%	NS	NS	NS	1.42
Interaction DxS				
D_1S_1	20.87	21.10	21.61	21.19
D_1S_2	21.87	22.10	22.59	22.19
D_1S_3	22.87	23.20	23.75	23.27
D_2S_1	23.33	23.67	24.19	23.73
D_2S_2	24.17	24.50	25.01	24.56
D_2S_3	25.27	25.60	26.14	25.67
D_3S_1	25.03	25.10	25.61	25.25
D_3S_2	26.33	26.67	27.18	26.73
D_3S_3	26.92	27.02	27.62	27.18
S.Em±	0.84	0.88	0.87	0.50
C.D. at 5%	2.53	2.63	2.60	1.42
CV%	10.54	10.81	10.46	10.60
	Y x D	Y x S	D x S	Y x D x S
S.Em. ±	0.86	0.86	0.50	1.49
C.D. at 5%	NS	NS	1.42	NS

The statistical analysis clearly indicated that with the fertilizer dose D_3 (150% RDF NPK @ 2250, 1125, 2250 g/palm/year) the highest nut length recorded in all the year as well as pooled data. But it was found at par with the fertilizer dose D_2 (125% RDF NPK @ 1875, 938, 1875 g/palm/year) in all the years as well as pooled analysis. There was no any significant difference observed in case of fertilizer application in split on nut length during individual years but found significantly higher in S_3 (Four Split (June-Aug.-Nov.-Feb.)) and found at par with S_2 (Three Split (June-Oct.-Feb.)) in pooled analysis. The results on interaction effect of DxS on nut length revealed that the different treatments on nut length was found significant during all years and pooled results. In the treatment combination D_3S_3 found the highest nut length (27.18 cm) but it was found at par with D_3S_2 in pooled results.

The results of different treatments on nut girth of coconut cv. TxD (Mahuva) was presented in table 2.

Table 2: Effect of different treatments on nut girth of coconut TxD (Mahuva)

Treatment	Nut girth of coconut (cm)			
	2014-15	**2015-16**	**2016-17**	**Pooled**
D (Factor A)				
D_1	42.66	41.55	42.12	42.11
D_2	42.07	41.30	41.52	41.63
D_3	40.66	40.43	40.87	40.65
S.Em.±	1.23	1.66	1.56	0.86
C.D. at 5%	NS	NS	NS	NS
S (Factor B)				
S_1	40.62	39.74	40.08	40.15
S_2	42.21	40.70	41.26	41.39
S_3	42.54	42.84	43.17	42.85
S.Em.±	1.23	1.66	1.56	0.86
C.D. at 5%	NS	NS	NS	NS
Interaction DxS				
D_1S_1	41.43	39.56	39.58	40.19
D_1S_2	43.13	41.61	43.25	42.66
D_1S_3	43.40	43.49	43.52	43.47
D_2S_1	41.53	41.62	41.65	41.60
D_2S_2	43.27	40.16	40.18	41.20
D_2S_3	41.40	42.12	42.74	42.09
D_3S_1	38.90	38.04	39.02	38.65
D_3S_2	40.23	40.32	40.35	40.30
D_3S_3	42.83	42.92	43.24	43.00
S.Em±	1.23	1.66	1.56	0.86
C.D. at 5%	NS	NS	NS	NS
CV%	8.90	12.11	11.30	10.84
	Y x D	Y x S	D x S	Y x D x S
S.Em. ±	1.49	1.49	0.86	4.92
C.D. at 5%	NS	NS	NS	NS

The results on nut girth presented in table 2 revealed that there is no any significant difference observed between treatments as well as treatment combinations in all the years as well as pooled analysis.

The results of different treatments on nut water content of coconut cv. TxD (Mahuva) was presented in table 3.

The statistical analysis clearly indicated that with the fertilizer dose D_3 (150% RDF NPK @ 2250, 1125, 2250 g/palm/year) the highest nut water content recorded in all the year as well as pooled data. And it was found at par with the fertilizer dose D_2 (125% RDF NPK @ 1875, 938, 1875 g/palm/year) in all the years but not in pooled results. The similar results found in fertilizer application in split on nut water content during all the years and pooled data. The significantly higher nut water content observed in S_3 (Four Split (June-Aug.-Nov.-Feb.)) and found at par with S_2 (Three Split (June-Oct.-Feb.)) in all the years except pooled analysis. The results on interaction effect of DxS on nut water content revealed that the different treatments on nut water content was found significant during all years and pooled results. In the treatment combination D_3S_3 found the highest nut water content (162 ml) but it was found at par with D_3S_2 in pooled results.

Solangi *et al.* (2014) also revealed that the quantity of nut water (188.77 ml) was significantly ($p<0.05$) high in T_1 (Urea (N), Di-ammoniumphosphate (P), Murait ofpotash (K), (NPK) + Neem Seed Powder (NSP) + Gliricidia sepium leaves (GSL)) as compared to rest of the treatments. Kalpana *et al.* (2008) reported that the water content of coconut increased with the application of fertilizers.

Table 3: Effect of different treatments on nut water content of coconut TxD (Mahuva)

Treatment	Nut water content (ml)			
	2014-15	2015-16	2016-17	Pooled
D (Factor A)				
D_1	108.94	120.40	124.37	117.90
D_2	130.07	141.53	145.41	139.01
D_3	141.09	152.55	156.42	150.02
S.Em.±	5.43	5.43	5.42	3.13
C.D. at 5%	16.27	16.26	16.25	8.91
S (Factor B)				
S_1	118.62	130.08	134.03	127.58
S_2	122.94	134.39	138.20	131.84
S_3	138.56	150.01	153.96	147.51
S.Em.±	5.43	5.43	5.42	3.13
C.D. at 5%	16.27	16.26	16.25	8.91
Interaction DxS				
D_1S_1	103	114	118	112
D_1S_2	112	123	127	121
D_1S_3	112	124	128	121
D_2S_1	120	131	135	128
D_2S_2	121	132	136	130
D_2S_3	150	161	166	159
D_3S_1	134	145	149	143
D_3S_2	136	148	152	145
D_3S_3	153	165	169	162
S.Em±	5.42	5.43	5.42	3.13
C.D. at 5%	16.27	16.27	16.25	8.91
CV%	12.85	11.78	11.45	12.00
	Y x D	Y x S	D x S	Y x D x S
S.Em. ±	5.42	5.42	3.13	9.39
C.D. at 5%	NS	NS	8.91	NS

The results of different treatments on nut yield (number of nuts) per hectare of coconut cv. TxD (Mahuva) was presented in table 4.

Table 4: Effect of different treatments on nut yield per ha of coconut TxD (Mahuva)

Treatment	Nut yield per ha. of coconut			
	2014-15	2015-16	2016-17	Pooled
D (Factor A)				
D_1	9679	10835	11644	10719
D_2	10805	11901	12919	11875
D_3	11141	12237	13156	12178
S.Em.±	387.05	418.57	419.09	235.86
C.D. at 5%	1160.44	NS	1256.50	671.32
S (Factor B)				
S_1	9778	10943	11662	10794
S_2	10410	11477	12743	11543
S_3	11437	12553	13314	12435
S.Em.±	387.05	418.57	419.09	235.86
C.D. at 5%	1160.44	1254.95	1256.50	671.32
Interaction DxS				
D_1S_1	9185	10370	11141	10232
D_1S_2	9719	10815	11704	10746
D_1S_3	10133	11319	12089	11180
D_2S_1	9363	10578	11401	10447
D_2S_2	11141	12148	13132	12140
D_2S_3	11911	12978	14222	13037
D_3S_1	10785	11881	12444	11704
D_3S_2	10370	11467	13393	11743
D_3S_3	12267	13363	13630	13086
S.Em±	387.06	418.58	445.05	241.08
C.D. at 5%	1160.44	1254.95	1134.31	686.18
CV%	11.02	10.77	10.57	10.79
	Y x D	Y x S	D x S	Y x D x S
S.Em. ±	417.57	417.57	308.24	723.25
C.D. at 5%	NS	NS	NS	NS

The statistical analysis shows that with the fertilizer dose D_3 (150% RDF NPK @ 2250, 1125, 2250 g/palm/year) the highest nut yield content recorded during the year 2014-15, 2016-17 as well as pooled data. And it was found at par with the fertilizer dose D_2 (125% RDF NPK @ 1875, 938, 1875 g/palm/year) in the year 2014-15, 2016-17. The significant results found in fertilizer application in split on nut yield during all the years and pooled data. The significantly higher nut yield observed in S_3 (Four Split (June-Aug.-Nov.-Feb.)) and found at par with S_2 (Three Split (June-Oct.-Feb.)) in all the years except pooled analysis. The results on interaction effect of DxS on nut yield revealed that the different treatments on nut yield was found significant during all years and pooled results. In the treatment combination D_3S_3 found the highest nut yield (13086) but it was found at par with D_2S_3 (13037) in pooled results.

The obtained results are in line with the findings of Anon. (2012) [1] in hybrid coconut varieties. In hybrid coconut varieties JVA1 and JVA2 the application of 110 kg N + 57 kg P_2O_5 + 140 kg K_2O/ha/year, increased productivity to 155 fruits/tree/year and the oil content was as high as 68%. According Long (2007) [6] application of fertilizers twice a year helped the tree grow, develop well and bear fruit early. Mohandas (2012) [7] concluded that for hybrid coconut, a fertilizer level of 1000:250:2000 g NPK/Palms/year along with 50 kg FYM was found to be economical for achieving higher nut yield and sustaining the soil fertility.

Coconut trees grow continuously and bear fruits all year round. Therefore, if fertilized many times a year, the tree will grow well, flower continuously increase the number of inflorescences and have high productivity. If divided and applied many times, the same amount of fertilizer will help trees absorb it more effectively and avoid losses (Tran and Nguyen, 2011) [9]. In particular, 4 times/year fertilized plots recorded high yields with a statistically significant difference as compared to 2 times/year fertilized (Nguyen *et al.*, 2020) [8].

Conclusion

As the coconut palm is perennial and producing nuts round the year. On the basis of the results obtained from the three-year field experimentation, it seems quite logical to conclude that higher number of nut yield of hybrid coconut cv. TxD (Mahuva) can be secured by the application of FYM 50 kg/palm/year with 125% RDF NPK @ 1875, 938, 1875 g/palm/year or 150% RDF NPK @ 2250, 1125, 2250 g/palm/year with four equal split [June-Sept-Dec.-March].

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