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Effect of Boron Fortified Konkan Annapurna Briquettes on Yield and Nut Splitting of Arecanut in Coastal Konkan Region of Maharashtra

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The present investigation was conducted at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Arecanut Research Station, Shriwardhan, Dist. Raigad, Maharashtra for three years during 2013-14 to 2015-16. The experiment was planned to maximize the yield of arecanut and to reduce the splitting of the arecanut through use of boron fortified Konkan Annapurna Briquettes (KAB). The treatment tested were namely, T_1- Recommended Dose of Fertilizers (RDF; 206:103:206 NPK ha^{-1}); T_2- RDF + 4 kg B ha^{-1} through soil application; T_3- Recommended Dose of Nitrogen (RDN) + 4 kg B ha^{-1} containing KAB; T_4- RDN + 2 kg B ha^{-1} containing KAB; T_5- 150 % RDF + 4 kg B ha^{-1} through soil application; T_6- 150 % RDN + 4 kg B ha^{-1} through KAB and T_7- 150 % RDN + 2 kg B ha^{-1} through KAB. Application of boron along with straight fertilizers significantly reduced the splitting of nuts while increasing the yield of arecanut. The results showed that the application of 150% RDN along with 4 kg B ha^{-1} through KAB recorded highest B:C ratio (2.07), net returns (₹3,52,052) with higher yield (6.82 t ha^{-1}) and lowest nut splitting (0.88%) of arecanut in Konkan region of Maharashtra.

(***Key words:*** *Arecanut, Boron, Konkan Annapurna briquettes, Nut splitting, Yield*)

Arecanut or betelnut (*Areca catechu* L.) is an important cash crop in the Western Ghats, Eastern Ghats, East and North Eastern regions of India. It is one of the important plantation crops of the India widely grown in the coastal area. In India arecanut is spread over in an area of 472.36 thousand ha having annual productivity of 1558 kg ha^{-1} with a production of 735.86 thousand tonnes. In Konkan region of Maharashtra, 2.35 thousand ha area is under arecanut with an annual production 3.48 thousand tonnes having annual productivity 1482 kg ha^{-1} (Anonymous, 2017). But as compared to other states, the productivity of arecanut in Konkan region of Maharashtra is very low. It might be due to the coastal saline soils of the region where the arecanut plantation is more. During the university level survey, it was found that the recommended dose of fertilizers is not fulfilling the nutrient requirement of the crop. It was also found that the splitting of the nuts is one of the reasons of low productivity and affects the quality of arecanut. In general, it was observed that 5-10 percent nuts were splitted during the season. It was therefore, decided to conduct the present investigation to maximize the yield and minimise the per cent splitting of the nut with the application of boronated fertilizer briquettes. Nut splitting is considered to be a physiological disorder rather than a pathological problem. The disease is also known as *Anduadakke roga* in Karnataka and *Achikeeral* in certain parts of Malabar in Kerala. This abnormality is seen patches in individual gardens and is common in young palms. The disease is characterised by the cracking of fruits, which may occur either near the perianth or the base or from both ends. Symptom appears as yellowing of the nuts when they are half to three fourth mature. Sometimes kernel also exhibits splitting. Improvement in drainage in areas of high water table helps in minimising the incidence. Spraying of Borax at the rate of 2 g L^{-1} of water during the early stage of disease reduces splitting (Nair, 1988).

Boron (B) is an essential micronutrient for plant growth and reproduction. It is important for carbohydrate metabolism and translocation. It plays role in movement of nutrient elements within the plant, formation of plant hormones affecting growth, pollen tube germination, root growth and health of fleshy roots. Boron influences flowering, fruit set, fruit development (Phookan *et al*., 1991). It plays important role in regulation of rate of photosynthesis and nodulation process. Boron is associated with the reproductive phase in plants and its

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deficiency is often found to be associated with sterility and malformation of reproductive organs. Number of investigations has shown that there is a definite and nearly constant requirement of N, P and K for production of high yielding crop varieties. Deep placement of briquettes is more efficient than conventionally applied prilled urea (Savant and Stangel, 1995). These briquettes release nutrients slowly, dramatically reducing the amount of fertilizer washed away by rain or absorbed by the air. Placement of nutrients not only has a positive impact but also an environmental benefit by reducing the nutrient load in runoff waters and reducing both volatilization and denitrification losses (Savant and Stangel, 1990). Briquettes dissolve slowly and maintain higher level of NO3 in soil up to the maximum period of growth (Reddy and Reddy, 1986) and thereby increasing nitrogen use efficiency. With this view, the present investigation was carried out to study the effect of B fortified Konkan Annapurna Briquettes (KAB) on yield and quality of arecanut.

MATERIAL AND METHODS

The experiment was conducted at Arecanut Research Station, Shriwardhan Dist. Raigad in Maharashtra for three consecutive years of 2013-14, 2014-15 and 2015-16. The Research Station is situated at 18° 3′ 33.84″ N latitude, 73° 1′ 22.08″ E longitude. The climate is tropical hot and humid with well-expressed three seasons i.e., summer (March to May), rainy (June to October) and winter (November to February). The region receives very high rainfall above 2000 mm annually from June to September. The experimental soil was neutral in reaction having 6.98 pH, 1.10 dSm^{-1} electrical conductivity, 243.6 kg ha^{-1} available nitrogen, 18.6 kg ha^{-1} available phosphorus, 264.2 kg ha^{-1} available potassium and 0.38 ppm hot water extractable boron. 10-15 years old palms of arecanut were selected for the study. Total seven treatments were replicated four times and laid in randomized block design for statistical analysis. In this investigation, Konkan Annapurna Briquettes (KAB) was used as a source of fertilizer in which boron was added/ fortified. The KAB are compressed fertilizer briquettes in which urea and 14:35:14 grade fertilizer (1.5:1 proportion) were mixed and compressed in Kranti briquetting machine. The boron was fortified in the briquettes while preparation through addition of borax. The briquettes thus formed are oval in shape weighing 2.7 g and containing 34:14:6:0.56 percent N, P_2O_5, K_2O and B. The treatment comprised of *viz*.; T_1-Recommended Dose of Fertilizers (RDF, 206:103:206 NPK ha^{-1}); T_2- RDF + 4 kg B ha^{-1} through soil application; T_3-Recommended Dose of Nitrogen (RDN) + 4 kg B ha^{-1} through KAB; T_4-RDN + 2 kg B ha^{-1} through KAB; T_5-150 % RDF + 4 kg B ha^{-1} through soil application; T_6-150 % RDN + 4 kg B ha^{-1} through KAB and T_7-150 % RDN + 2 kg B ha^{-1} through KAB.

The fertilizers including KAB in all the treatments were applied by ring method during June and October months in every year of the investigation. In the treatments T_1, T_2 and T_5, the straight fertilizers were applied and in remaining treatments, Konkan Annapurna Briquettes were used. Borax was used as a source of boron. The yield and yield attributes were recorded along with observation on nut splitting. The benefit cost ratio for all treatments were calculated. All the data of the investigation was analysed statistically as per the procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSIONS

Effect of boronated briquettes on yield and number of fruits per palm

The data on arecanut fresh yield and number of fruits per palm is given in Table 1. In general an increasing trend in the yield of arecanut was noticed with the increasing amounts of nutrients added. From the pooled data, it was observed that the T_6 treatment consisting of 150% RDN + 4 kg B ha^{-1} through KAB recorded highest yield (11.56 kg per palm) and highest number of fruits per palm (357.42) which found to be at par with all treatments except T_1 (RDF) and T_7 (150 % RDN + 2 kg B ha^{-1} through KAB). Similar trend was observed in case of number of fruits per plant and significantly the highest number of fruits per palm (357.42) was recorded in the T6 treatment consisting of 150% RDN + 4 kg B ha^{-1} through KAB, while the lowest (245.34) was obtained in treatment T_1 where only recommended dose of N, P and K was applied. Boron plays an important role in the translocation of photosynthates to the growing parts and also in developing fruits which might have ultimately led towards increase in number and weight of the fruits. Also there is slow release of the primary nutrients for the tar coated fertilizer briquettes *i.e*., KAB nutrients supplying the nutrients up to 45 days after application. This might have helped in maintaining

Table 1. *Effect of boron containing briquettes on yield kg per palm and number of nuts per palm of arecanut*

Treatments	Nut yield kg per palm (Fresh wt.)				Number of nuts per palm			
	2013-14	2014-15	2015-16	Pooled	2013-14	2014-15	2015-16	Pooled
T_1: Recommended dose of fertilizers	7.50	9.38	8.35	8.41	223.63	286.25	226.13	245.34
T_2: RDF + 4 kg B ha^{-1} through soil application	8.88	9.28	10.23	9.46	272.75	339.50	266.50	292.92
T_3: RDN + 4 kg B ha^{-1} containing KAB	11.38	7.8 8	12.51	10.59	296.38	249.75	287.50	277.88
T_4: RDN + 2 kg B ha^{-1} containing KAB	8.44	9.63	10.21	9.43	245.38	292.13	247.13	261.55
T_5: 150 % RDF + 4 kg B ha^{-1} through soil application	11.88	10.23	9.57	10.56	289.25	268.00	282.50	279.92
T_6: 150 % RDN + 4 kg B ha^{-1} containing KAB	11.50	13.00	10.20	11.56	384.00	308.25	380.00	357.42
T_7: 150 % RDN + 2 kg B ha^{-1} containing KAB	10.13	8.73	8.65	9.17	311.63	251.25	286.63	283.17
SE ±	0.78	0.50	0.55	0.75	17.89	17.55	14.30	19.20
CD(P=0.05)	2.35	1.47	1.63	2.31	53.16	52.14	42.50	60.70

a continuous supply of nutrients in between the different physiological growths (Srivastava *et al*., 2009) leading to improved growth and yield of the crop. Similar results on application of KAB were also reported in cucumber crop by Torane (2014).

Effect of boronated briquettes on splitting of nuts

The data regarding splitting of nuts is presented in Table 2 and it indicated that during every year of the investigation, the splitting of arecanut was decreased drastically due to the application of boron as borax in soil as well as through the fortified boronated KAB along with NPK fertilizers. From the pooled data (Table 2), it was observed that the lowest number of splitted nuts (3.01) was recorded in the T_2 treatment consisting of RDF + 4 kg B ha^{-1} through soil application. However, this treatment T_2 was at par with all other treatments except T_1 and T_7. A perusal of the data (Table 2) revealed that the lowest per cent splitting in arecanut (0.88%) was recorded in T_6 treatment followed by the T_2 treatment (1.03%).

Boron is one of the mineral nutrients that is required for normal growth of plants and is implicated in numerous plant growth functions indirectly or directly. It responsible for the division and enlargement of cells in freshly emerging shoot and root tips. Also it is vital for flowering, pollination, boll formation, seed development and the transport of sugar contained by the plant organs (Atwell *et al*., 1999; Hu and Brown, 1994). Boron significantly affects the plant growth as it has specific role in sugar transport (Marschner, 1995), cell wall synthesis and lignification (Loomis and Durst, 1991; Hu *et al*., 1996; Matoh *et al*., 1996, cell wall structure (Blevins and Lukaszewski, 1998; Fleischer *et al*., 1998), carbohydrate metabolism (Shelp, 1993), RNA metabolism, respiration, indole acetic acid metabolism, phenol metabolism and membrane transport. Application of boron to the arecanut must have resulted in better regulation of all these physiological processes leading to increased fruit set and decrease in splitting of nuts.

Economics

The economics of the cultivation of arecanut affected by different treatments is presented in Table 3. The highest B:C ratio (2.07) as well as maximum net returns (₹3,52,052) was recorded in the T_6 treatment *i.e*., application of 150 % RDF along with 4 kg B ha^{-1} through KAB followed by the T_3 and T_5 treatments. The lowest net returns (₹2,10,212) and B:C ratio (1.74) was recorded in the treatment T_1 where only NPK fertilizer was applied.

Table 2. *Effect of boron containing briquettes on number of splitted nuts per palm and on per cent splitting per palm*

Treatment Details	Number of splitted nuts per palm			
	2013-14	2014-15	2015-16	Pooled
T_1: Recommended dose of fertilizers	11.65 *(5.21)*	9.85 *(3.44)*	10.60 *(4.69)*	10.70 *(4.36)*
T_2: RDF + 4 kg B ha^{-1} through soil application	1.97 *(0.72)*	3.31 *(0.97)*	3.76 *(1.41)*	3.01 *(1.03)*
T_3: RDN + 4 kg B ha^{-1} containing KAB	3.60 *(1.21)*	5.12 *(2.05)*	3.16 *(1.10)*	3.96 *(1.43)*
T_4: RDN + 2 kg B ha^{-1} containing KAB	4.60 *(1.87)*	3.46 *(1.18)*	3.41 *(1.38)*	3.82 *(1.46)*
T_5: 150 % RDF + 4 kg B ha^{-1} through soil application	2.93 *(1.01)*	3.54 *(1.32)*	3.22 *(1.14)*	3.23 *(1.15)*
T_6: 150 % RDN + 4 kg B ha^{-1} containing KAB	3.16 *(0.82)*	3.10 *(1.01)*	3.17 *(0.83)*	3.14 *(0.88)*
T_7: 150 % RDN + 2 kg B ha^{-1} containing KAB	4.64 *(1.49)*	5.22 *(2.08)*	5.03 *(1.75)*	4.96 *(1.75)*
SE ±	0.50	0.64	0.55	0.43
CD (P=0.05)	1.49	1.91	1.63	1.32

(Figures in parenthesis indicates per cent splitting per palm)

Table 3. *Per hectare cost of cultivation of the treatments (Based on the pooled data)*

Treatments	Fresh wt. (t ha^{-1})	Dry wt. (t ha^{-1})	Total cost (₹)	Total returns (₹)	Net returns (₹)	B:C ratio
T_1: Recommended dose of fertilizers	11.54	4.96	285788	496000	210212	1.74
T_2: RDF + 4 kg B ha^{-1} through soil application	12.98	5.58	299062	558000	258938	1.87
T_3: RDN + 4 kg B ha^{-1} containing KAB	14.53	6.25	306181	625000	318819	2.04
T_4: RDN + 2 kg B ha^{-1} containing KAB	12.94	5.56	283405	556000	272595	1.96
T_5: 150 % RDF + 4 kg B ha^{-1} through soil application	14.49	6.23	314072	623000	308928	1.98
T_6: 150 % RDN + 4 kg B ha^{-1} containing KAB	15.86	6.82	329948	682000	352052	2.07
T_7: 150 % RDN + 2 kg B ha^{-1} containing KAB	12.58	5.41	295172	541000	245828	1.83

The application of boron showed significantly positive results in terms of reduction in splitting of nuts as well as increasing the yield of arecanut. Based on the B:C ratio, net returns, highest yield and minimum percentage of nut splitting, it is recommended to apply 150 % RDN along with 4 kg B ha^{-1} to arecanut through fortified Konkan Annapurna Briquette (KAB) to reduce the nut splitting and obtain higher yield in Konkan region of Maharashtra.

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