

Original Research Article

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Studies on Effect of Graded Level of Application of Boron and Potassium on Arecanut (*Areca catechu* L.) and their Interaction on Boron Content in the Soil, Leaf, Nut and Yield Parameter in Terai Region of West Bengal

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ABSTRACT

The experiment was conducted during the year 2017-18 at the instructional farm of Department of Plantation Crops and Processing, Faculty of Horticulture, Uttar Banga Krishi Vishwavidyalaya, West Bengal. The study was aimed to evaluate the effect of graded level application of boron and potassium and their interaction on boron content in soil, leaf and nut (mg/kg) and their interaction effect on yield parameter in the boron deficient soils of *terai* region of West Bengal. The experiment was carried out in a 2.7×2.7 m spaced 12 year old planted with cv. Mohitnagar and laid out in factorial RBD having 12 treatments replicated 4 times with 4 different level of boron viz., B₀, B₁, B₂ and B₃ at 0g, 25g, 50g and sprayed with 4% Na₂B₄O₇ solution along with 3 different level of potassium (K₂O) viz., K₁, K₂ and K₃ at 70 g, 140 g, 210 g of K₂O per palm respectively to the bunches at 2nd, 4th and 6th months respectively per palm at nut development stage at regular intervals. Soil and nut samples are collected from 10 equidistant spots and 10 different palms respectively whereas leaf sample is collected from the 4th index leaf (Ravi Bhat and Sujatha, 2014) from 10 equidistant palms for analysis before and after application of treatments. The results revealed that graded level application of boron and potassium shows that at higher level of boron (B₂) and potassium (K₃) the boron content is gradually increased in the soil, leaf and nut (mg/kg) and their interaction effect shows that, higher level combination of both boron and potassium (B₂K₃) shows higher boron content in the soil, leaf and nut (mg/kg) and at B₃K₂ and B₂K₂ level of interaction the yield parameters shows significant effect.

Keywords

Arecanut
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Introduction

The Arecanut is the fruit of the areca palm (*Areca catechu*) popularly known as betelnut belongs to family arecaceae which grows in

much of the Tropical pacific (Melanania and Micronesia), South East Asia and South Africa. It is mainly chewed with the betel leaves, lime, with or without tobacco. The value added form of consumption is by way of

pan masala and scented supari. The nut has got some medicinal and nutraceutical properties. It is health activator, mouth freshener and has digestive properties. Arecanut can be used for the following purposes like masaj powder, soaps and shampoos, cosmetics, antihelmintic and anti-diabetic, areca wine making, areca soft drink, ayurvedic type of thamboola for chewing purpose, ulcer healing combination, hair oil and dyes, food colours and skin ointments (Prakash, 2010). Soil fertility is one of the important factors controlling the crop yield; soil related limitations affecting the crop productivity including nutritional disorders can be determined by evaluating the fertility status of soils. Soil testing provides the information about the nutrient availability of the soil upon which the fertilizer recommendation for maximizing crop yield is made. Boron and Potassium nutrients play a vital role in the growth and development of arecanut palm where all palms are potassium lovers, required in larger quantity for the development of nuts etc., hence it has to be supplied to the plants in the adequate quantity, both excess supply of minerals and limited supply of nutrients leads to different problems. Due to nutrient deficiency in *Terai* region soil the plantation under this region are showing greater extent of potassium and boron deficiency which directly effect on nut development which is leading to nut fall, which ultimately reduces the yield of the crop, hence in order to mitigate the problems faced in these regions, it has to be studied scientifically and need to give a solution for all the problems facing related to soil micro and macro nutrients by analyzing the soil, leaf and nut boron and potassium content in interaction with yield parameters.

Materials and Methods

The experiment was carried out during 2017-18 at the Instructional Plots of the Department

of Plantation Crops and Processing, Uttar Banga Krishi Viswavidyalaya, West Bengal. Physico-chemical properties of the soil analysed by standard methods were soil texture- sandy loam, pH - 5.45 (Jackson, 1973), electrical conductivity - 0.06 dsm-1 (Jackson, 1973), available N - 159.62 kg/ha (Alkaline $KMnO_4$ method, Subbiah and Asija, 1956), available P - 23.15 kg/ha (Acid extractable method, Bray and Kurtz, 1945), available K - 145.3 kg/ha (1N ammonium acetate method, Jackson, 1967), and available B - 1.77 mg/kg (Hot water extractable as proposed by Berger and Truog (1939)). The experiment was laid out in Factorial Randomised Block Design with 12 treatments replicated 4 times with 4 different level of boron viz B₀, B₁, B₂ and B₃ at 0g, 25g, 50g and sprayed with 4% $Na_2B_4O_7$ solution along with 3 different level of potassium (K_2O) viz K₁, K₂ and K₃ at 70 g, 140 g, 210 g of K_2O per palm respectively to the bunches at 2nd, 4th and 6th months respectively per palm at nut development stage at regular intervals. The 12 different treatment combinations were given in Table 1.

All the palms which are under treatment had given Nitrogen, Phosphorous, potassium and the boron in the form of urea (46%), single super phosphate (16% P_2O_5), muriate of potash (60% K_2O) and Borax (10.5 % B) respectively. According to the treatment details, the palms were applied with 4 different level of boron viz., B₀, B₁, B₂ and B₃ at 0g, 25g, 50g and sprayed with 4% $Na_2B_4O_7$ solution along with 3 different level of potassium (K_2O) viz., K₁, K₂ and K₃ at 70 g, 140 g, 210 g of K_2O per palm respectively to the bunches at 2nd, 4th and 6th months respectively per palm at nut development stage at regular intervals. A constant dose of Nitrogen was applied in the form of Urea at 109g/palm and phosphorous (P_2O_5) at 125g/palm in two equal splits at pre and post monsoon.

Fertilizer are applied in basins around the palm dug to a depth of 15-20cm and 0.75-1.0 m radius from the base of the palm and after the application to the basins were thoroughly mixed with the soil and covered with the top soil. The fertilizer application as stated was followed with light irrigation (Nathanael, 1967 and Dew saliva, 1968). The initial soil samples 0-15 cm and 15-30 cm depth were collected randomly throughout the experimental plots before commencement of application of fertilizers mentioned in the experimental details. The soil samples were drawn from the selected from a Dutch Auger (Make: AIC Agro-Industries Private Ltd, Kolkata) as initial sample and later as final sample after the completion of experiment. The sample were collected from base of each palm as separate treatment according to the replication and maintained separately for analysis. In the process, the bulk soil was reduced to 1 kg by following the quartering method. This 1 kg soil sample constituted the composite soil sample. The composite soil samples were then air dried, passed through a 2 mm sieve and stored in clean dry cloth bags with adequate descriptions in attached paper labels. All relevant information and identification marks as required were also recorded. These composite soil samples were analysed in the laboratory for the required soil characteristics and properties and some of the parameters like pH (Jackson, 1973), electrical conductivity (Jackson, 1973), available N (Alkaline $KMnO_4$ method, Subbiah and Asija, 1956), available P (Acid extractable method, Bray and Kurtz, 1945), available (1N ammonium acetate method, Jackson, 1967), and available B (Hot water extractable as proposed by Berger and Truog (1939) has been analysed and also Leaf samples were collected from the 4th index leaf (Bhat and Sujatha, 2014) from 10 equidistant palms for analysis before application of the fertilizer and after completion of the experiment from each palm as per the treatment, 4 samples were

collected from each treatment and the bulking of sample and kept separately for analysis and then determination of boron and potassium content in the leaf sample were done.

The collected leaf samples were brought to the laboratory and washed immediately with tap water and then rinsed with 0.1 N HCl. The washed and rinsed samples were dried under shade followed by oven drying at a temperature of 65 ± 5 °C so as to reduce the chemical and biochemical changes to the minimum. The oven dried samples were powdered and stored in butter paper bags for chemical analysis. In the same way nut samples were collected after oven drying the dehusked arecanut, the kernel was dried separately in the oven after separating husk and kernel and then the kernel was grinded, powdered again oven dried and it was kept separately according to the treatment with its replication and proceeded for analysis for both leaf and nut samples of both boron and potassium content has been analysed using Azomethin- H method and wet digestion method by using tri-acid respectively.

Results and Discussion

Effect of graded level of application of boron and potassium and their interaction on Boron content in soil, leaf and nut (mg/kg)

Effect of boron and potassium application and their interaction on boron content in the soil (mg/kg)

Soil analysis data recorded a higher concentration of boron recorded a higher concentration of boron in the soil even at without application of boron (1.28 mg/kg) and showed directly proportionate relationship to the application of boron. The treatment comprising of without application of boron (B_0) and bunch spraying (B_3) recorded

statistically at par data. As per the analyzed data, it is observed that B₂ (2.52 mg/kg) (Fig. 1) shows significantly higher boron content in the soil and B₀ level (1.28 mg/kg) recorded lower boron content in the soil and also boron content in the soil may also varies based on application of potassium fertilizers at different grades data revealed that treatment K₃ (2.24 mg/kg) showed significantly higher boron content in the soil and K₁ (1.43 mg/kg) (Table 2; Fig. 1) shows significantly lower boron content.

In the interaction effect of both boron and potassium, the experiment data revealed that B₂K₃ (3.58 mg/kg) recorded significantly higher boron content in the soil followed by B₂K₁ (2.13 mg/kg) and B₁K₃ (2.06 mg/kg) and at the same time B₀K₁ (0.91 mg/kg) (Table 2; Fig. 2) showed significantly lower boron content in the soil. On the other hand bunch spraying of 0.4% borax recorded an increasing trend of boron concentration of soil with the increasing application of K in the soil. From the above result it may be concluded that the experimental soils recorded higher boron concentration might be due to regular application of boron into the soil and its concentration increased due to increased rate of soil application of boron.

Effect of boron and potassium application and their interaction on boron content in the leaf (mg/kg)

The boron content of the index leaf also observed a similar trend as in case of soil B₂ level of boron application recorded significantly higher boron content in the leaf (Fig. 1) and B₀ showed lowest boron content in the soil (181.82 mg/kg) (Table 2; Fig. 1) where as K₁ and K₂ level of application recorded significantly lower boron content in the leaf.

Interaction effect of boron and potassium on boron concentration in leaf revealed that B₂K₃

(225.20 mg/kg) shows significantly higher boron content in the leaf may be due to higher presence of boron in the soil, followed by B₃K₁ (208.13 mg/kg) (Table 2; Fig. 2) and at the same time B₀K₁ recorded significantly lower boron content in the leaf (109.40 mg/kg).

Effect of boron and potassium application and their interaction on boron content in the nut (mg/kg)

Boron concentration in the nut under the treatments is also showed significantly increasing trend as reflected in leaf boron concentration of the palms with the increase in soil application of both the elements and subsequently, B₂ and K₂ level of application recorded 51.63 mg/kg and 43.18 mg/kg respectively. Without application of boron recorded significantly lowest boron content (24.93 mg/kg) followed by bunch spraying of 0.4% borax (28.40) (Table 2; Fig. 1). The interaction effect of both boron and potassium on boron content in nut reveals the B₂K₃ (87.06 mg/kg) is having significantly higher boron content in the nut followed by B₁K₂ (48.30 mg/kg) and B₂K₂ (37.77 mg/kg) (Fig. 2) but at the same time B₀K₁ (19.73 mg/kg) (Table 2; Fig. 1) shows significantly lower boron content in the nut due to lower boron content in the soil as well as leaf.

Interaction effect of boron and potassium application on fresh kernel weight (g) and Dry kernel weight (g)

Interaction effect of boron and potassium application on fresh kernel weight (g)

The results with respect to the effect of boron and potassium at different levels indicated that B₃K₂ (13.03 g) (Fig. 3) produced significantly higher kernel weight and was *at par* with remaining all 10 treatments but B₂K₁ (10.18 g) (Fig. 3) produced significantly lower kernel weight.

Table.1 Treatment details

T₁: B₀K₁	0 g borax/palm (0g B) + 70 g K₂O/palm
T₂: B₀K₂	0 g borax/palm (0g B) + 140 g K ₂ O/palm
T₃: B₀K₃	0 g borax/palm (0g B) + 210 g K ₂ O/palm
T₄: B₁K₁	25 g borax/palm(2.63g B) + 70 g K ₂ O/palm
T₅: B₁K₂	25 g borax/palm (2.63g B) + 140 g K ₂ O/palm
T₆: B₁K₃	25 g borax/palm (2.63g B) + 210 g K ₂ O/palm
T₇: B₂K₁	50 g borax/palm(5.25g B) +70 g K ₂ O/palm
T₈: B₂K₂	50 g borax/palm (5.25g B) +140 g K ₂ O/palm
T₉: B₂K₃	50 g borax/palm (5.25g B) + 210 g K ₂ O/palm
T₁₀: B₃K₁	Spray 0.4% Na ₂ B ₄ O ₇ +70 g K ₂ O/palm
T₁₁:B₃K₂	Spray 0.4% Na ₂ B ₄ O ₇ + 140 g K ₂ O/palm
T₁₂: B₃K₃	Spray 0.4% Na ₂ B ₄ O ₇ + 210 g K ₂ O/palm

Table.2 Effect of graded level of application of boron and potassium and their interaction on Boron content in soil, leaf and nut (mg/kg)

Treatment	Boron content in the soil (mg/kg)	Boron content in the leaf (mg/kg)	Boron content in the nut (mg/kg)
B₀	1.28	147.84	24.93
B₁	1.76	174.52	34.79
B₂	2.52	200.54	51.63
B₃	1.45	170.53	28.40
S.Em(±)	0.08	1.52	0.72
C.D. (0.05)	0.23	4.45	2.12
K₁	1.43	168.86	27.27
K₂	1.58	169.41	34.43
K₃	2.24	181.82	43.18
S.Em(±)	0.07	1.31	0.63
C.D(0.05)	0.19	3.86	1.83
B₀K₁	0.91	109.40	19.73
B₀K₂	1.45	113.00	26.77
B₀K₃	1.49	121.13	28.30
B₁K₁	1.45	153.13	27.30
B₁K₂	1.77	180.47	48.30
B₁K₃	2.06	189.97	28.77
B₂K₁	2.13	204.77	30.07
B₂K₂	1.85	171.67	37.77
B₂K₃	3.58	225.20	87.06
B₃K₁	1.24	208.13	24.97
B₃K₂	1.27	190.97	31.93
B₃K₃	1.85	112.50	28.30
S.Em(±)	0.13	2.63	1.25
C.D(0.05)	0.39	7.71	3.67

Table.3 Interaction effect of boron and potassium application on fresh kernel weight (g) and dry kernel weight

Treatment	Fresh kernel weight (g)	Dry kernel weight (g)
B₀K₁	11.34	3.00
B₀K₂	12.32	3.61
B₀K₃	12.64	3.01
B₁K₁	12.41	3.26
B₁K₂	12.74	3.01
B₁K₃	12.33	3.09
B₂K₁	10.18	3.01
B₂K₂	12.94	3.88
B₂K₃	11.84	3.11
B₃K₁	10.82	3.00
B₃K₂	13.03	3.73
B₃K₃	12.53	3.44
S.Em(±)	0.64	0.29
C.D.(0.05)	1.88	0.85

Fig.1 Effect of graded level of application of boron and potassium on boron content in soil, leaf and nut (mg/kg)

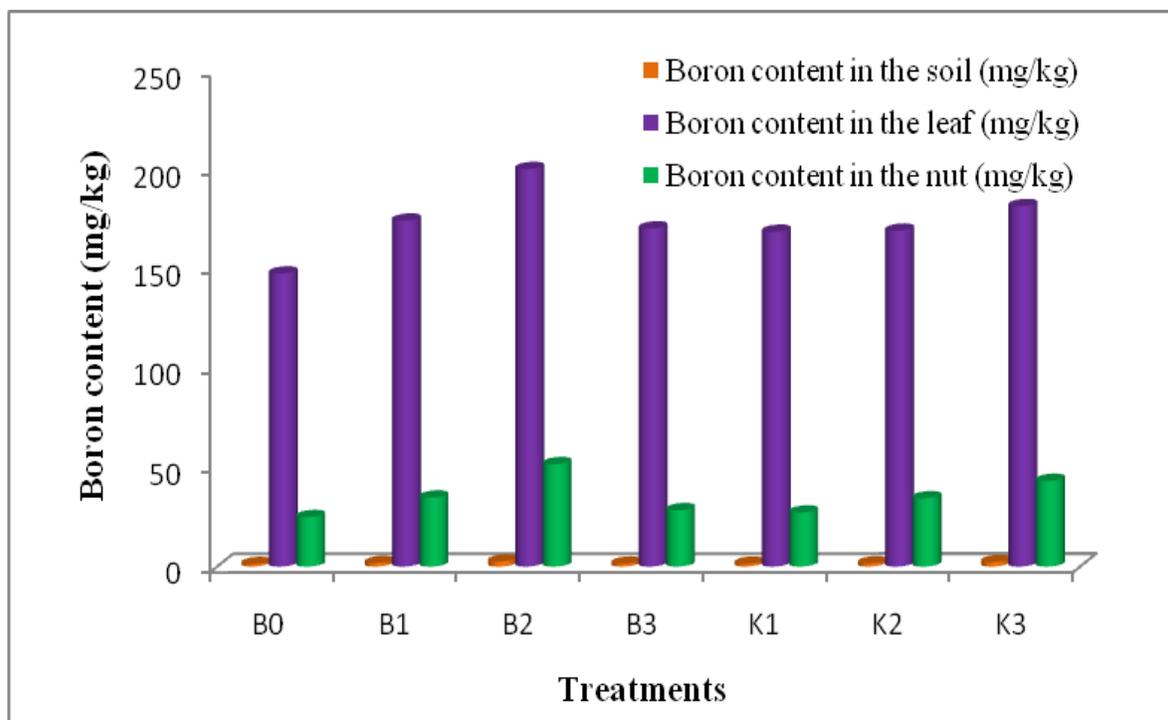


Fig.2 Interaction effect of graded level of application of boron and potassium on boron content in soil, leaf and nut (mg/kg)

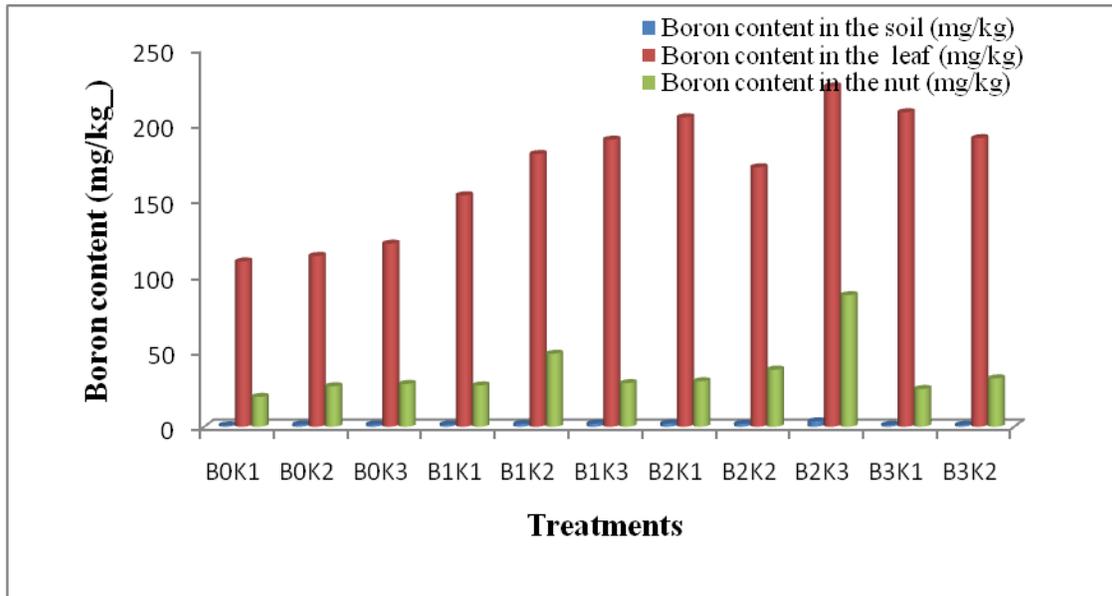
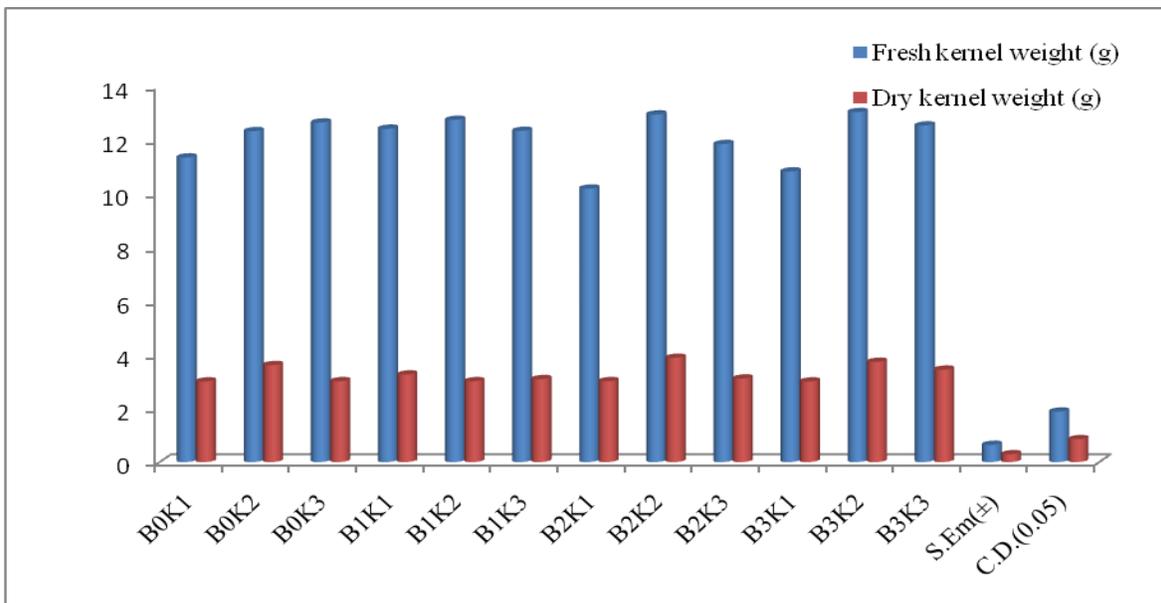


Fig.3 Interaction effect of boron and potassium application on fresh kernel weight (g) and dry kernel weight



The data suggested that bunch spray with higher dose of potassium had a significant effect at lower boron concentration in soil and helped potassium play a role in physiological activity.

Interaction effect of boron and potassium application on dry kernel weight (g)

Interaction effect of both minerals, the experimental data reveals that B₂K₂ (3.80 g) level shows significantly higher dry kernel

weight followed by B₃K₂ (3.73 g) and B₀K₂ (3.61 g) (Table 3; Fig. 3) as noticed with respect to fresh kernel weight, may be due to better combination of both nutrients and B₀K₁ level of application recorded significantly lower dry kernel weight(3.00 g) due to lower availability and ultimately reflected in dry matter accumulation.

From the experiment we can conclude that the graded levels of boron and potassium and their interaction indicated that there was a significant increase in boron level of soil, leaf and nut with increase level of soil application of boron and potassium. The interaction of both the elements was also showed the similar effect with respect to boron concentration

In the present experiment, yield attributing characters of the arecanut have also observed varied response with application of different combination of boron and potassium. Soil application of 25 g boron and 140 g potassium per palm recorded the maximum fresh kernel weight of the nuts and dry kernel weight recorded its maximum value with bunch spray along with soil application of 140 g potassium. However, the treatment combination B₃K₂ performed the best with respect to fresh kernel weight and B₂K₂ performed the best with respect to dry kernel.

Better yield of arecanut cv Mohitnagar can be achieved through combined soil application of 25 g borax with 140 g potash along with 100 g nitrogen and 40 g phosphorous. Regular soil

application of boron increases the boron concentration of soil, leaf and nut which hinders the increased uptake of potassium.

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