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Impact of boron and potassium and their interaction on potassium content in the soil, leaf, nut and yield parameters of Arecanut 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 potassium content in soil, leaf and nut (mg/kg) and their interaction effect on yield parameter in the potassium 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 B_0, B_1, B_2 and B_3 at 0g, 25g, 50g and sprayed with 4% $Na_2B_4O_7$ solution along with 3 different level of potassium (K_2O) viz K_1, K_2 and K_3 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. Soil and nut samples are collected from 10 equidistant spots and 10 different palms respectively where as 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(B_2) shows increased potassium content in the soil and nut where as at (B1) the potassium content of the leaf showed highest and at (K3) the potassium content of the soil and nut showed highest potassium and at K2 level the potassium content of leaf is gradually increased (mg/kg) and their interaction effect shows that, higher level combination of both boron and potassium(B_2K_3) shows higher potassium content in the soil and nut(mg/kg) and also 0 level of boron and highest level of potassium showed increase3d potassium content in the leaf(B_0K_3) and aslo at B_3K_2 and B_2K_2 level of interaction the yield parameters like (fresh kernel weight and dry kernel weight) shows significant effect.

Keywords: Arecanut, boron, potassium, fresh kernel weight, dry kernel weight, leaf, soil and nut nutrient analysis

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 (Melanasia 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 neutracritical properties. It is health activator, mouth freshner 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) [8].

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 plays 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) [5], electrical conductivity - 0.06 dsm-1 (Jackson, 1973) [5], available N - 159. 62 kg/ha (Alkaline $KMnO_4$ method, Subbiah and Asija, 1956) [10], available P - 23.15 kg/ha (Acid extractable method, Bray and Kurtz, 1945) [3], 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) [1].

The experiment was laid out in Factorial Randomised Block Design with 12 treatments replicated 4 times with 4 different level of boron viz B_0, B_1, B_2 and B_3 at 0g, 25g, 50g and sprayed with 4% $Na_2B_4O_7$ solution along with 3 different level of potassium (K_2O) viz K_1, K_2 and K_3 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 as follows:

T_1 : B_0K_1	0 g borax/palm (0g B) + 70 g K_2O/palm
T_2 : B_0K_2	0 g borax/palm (0g B) + 140 g K_2O/palm
T_3 : B_0K_3	0 g borax/palm (0g B) + 210 g K_2O/palm
T_4 : B_1K_1	25 g borax/palm(2.63g B) + 70 g K_2O/palm
T_5 : B_1K_2	25 g borax/palm (2.63g B) + 140 g K_2O/palm
T_6 : B_1K_3	25 g borax/palm (2.63g B) + 210 g K_2O/palm
T_7 : B_2K_1	50 g borax/palm(5.25g B) +70 g K_2O/palm
T_8 : B_2K_2	50 g borax/palm (5.25g B) +140 g K_2O/palm
T_9 : B_2K_3	50 g borax/palm (5.25g B) + 210 g K_2O/palm
T_{10}: B_3K_1	Spray 0.4% $Na_2B_4O_7$ +70 g K_2O/palm
T_{11}:B_3K_2	Spray 0.4% $Na_2B_4O_7$ + 140 g K_2O/palm
T_{12}: B_3K_3	Spray 0.4% $Na_2B_4O_7$ + 210 g K_2O/palm

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 plams were applied with 4 different level of boron viz B_0, B_1, B_2 and B_3 at 0g, 25g, 50g and sprayed with 4% $Na_2B_4O_7$ solution along with 3 different level of potassium (K_2O) viz K_1, K_2 and K_3 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) [7]. 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) [5], electrical conductivity (Jackson, 1973) [5], available N (Alkaline $KMnO_4$ method, Subbiah and Asija, 1956) [10], available P (Acid extractable method, Bray and Kurtz, 1945) [3], available (1N ammonium acetate method, Jackson, 1967) [4], and available B (Hot water extractable as proposed by Berger and Truog (1939) [1] has been analysed and also Leaf samples were collected from the 4th index leaf (Bhat and Sujatha, 2014) [2] 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 ºC 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-

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

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

Potassium content in the soil indicates that the maximum level of application of both boron and potassium recorded higher potassium content in the soil, from the table 1, it can say that at B2 level of application of boron shows significant increased (223.36 mg/kg) of potassium content in the soil whereas, zero level of application of boron may be due presence of higher boron content in the experimental soil but bunch spray of boron shows significantly lower (157.48 mg/kg) (Table 1) (Fig 1) potassium content in the soil,and at higher level of application of potassium i.e K3 (233.69 mg/kg) recorded maximum potassium content in the soil whereas K1 (199.97 mg/kg) i.e. lower application of potassium recorded decreased in potassium content in the soil and as the level of potassium increase the potassium content in the soil also increased accordingly (Table 1).

The interaction of boron and potassium at different level are recorded and the data revealed that at B2K2 level of combination, the potassium content in the soil increased sharply and recorded maximum (306.86 mg/kg) (Table 1) (Fig 2), whereas, in B2K3 even after application of higher dose of potassium, it was recorded significantly lower potassium in soil (209.08 mg/kg) may be due to antagonistic effect of both the nutrients at higher level. The finding is in conformity with the findings of Sathya *et al.*, 2013 [9] and observed that when boron application was increased more than 25 kg/ha in tomato in Tamil Nadu condition had decreased the available soil potassium content from 209 to 207 kg/ha.

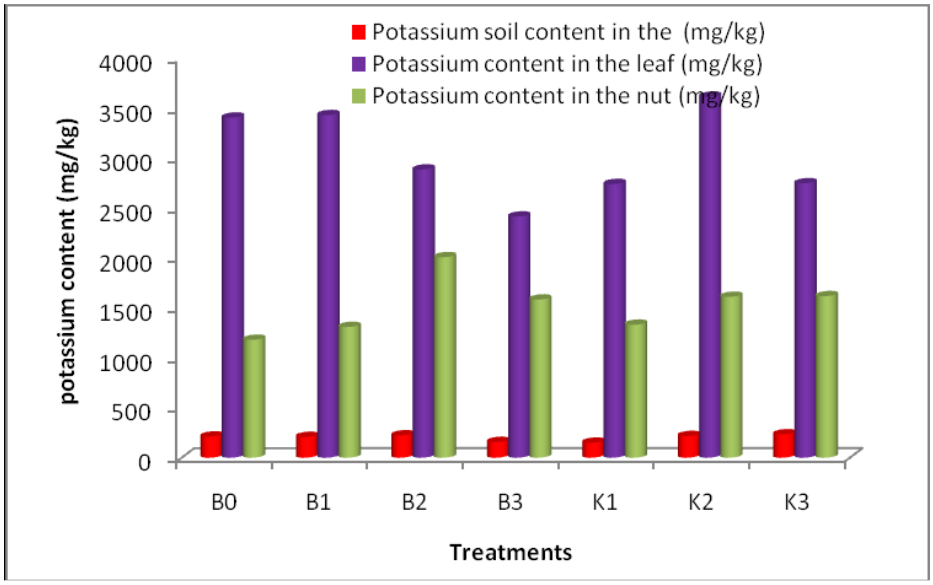

Fig 1: Effect of graded level of application of boron and potassium on Potassium content in soil, leaf and nut (mg/kg)

1.2. Effect of boron and potassium application on potassium content of leaf (mg/kg)

The results pertaining to the effect of boron at different levels on leaf potassium are presented in (table 1) and (fig 3). – A look into the results showed that the leaf potassium levels were increased to some extent with an increase level of application of boron from B0 to B1. The B1 level of boron application recorded significantly higher potassium content in the leaf which might be due to toxic level of boron in the soil solution and excess supply of boron in the growth medium reduced uptake of potassium and vice versa as observed by Mengel and Kirkby (2001) [6].

Similarly, K2 level of potassium application recorded significantly higher potassium content in the leaf and even after application of higher dose of soil application of potassium at K3 level failed to show higher potassium content of the leaf might be due higher boron concentration of the experiment at soil creating an imbalance which hinders in increased uptake of potassium.

A perusal of data relating to boron –potassium interaction effects on leaf potassium content revealed (table -1) that B0K3 level recorded significantly higher leaf potassium (4365.77 mg/kg) (Table 1) (Fig 3) compared to all other treatments followed by B1K1 (3684.23 mg/kg) and B1K3 (3633.07 mg/kg) and bunch spraying of 0.4% borax along with lowest level of potassium application (B3K1) recorded significantly lowest (1169.03) potassium content in leaf due lowest concentration of potassium in soil (105.34mg/kg).

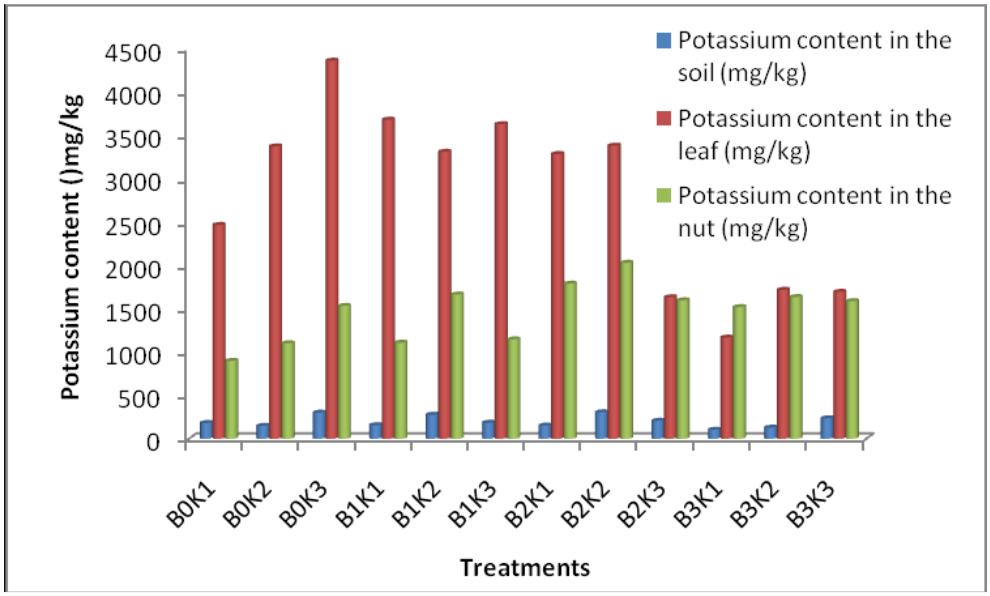

Fig 2: Effect of graded level of application of boron and potassium and their interaction on Potassium content in soil, leaf and nut (mg/kg)

Table 1: Effect of graded level of application of boron and potassium and their interaction on Potassium content in soil, leaf and nut(mg/kg)

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

Treatment	Potassium content in the soil (mg/kg)	Potassium content in the leaf (mg/kg)	Potassium content in the nut (mg/kg)
B_0	211.87	3403.88	1179.57
B_1	207.62	3428.69	1308.44
B_2	223.36	2884.12	2006.22
B_3	157.48	2413.53	1582.67
S.Em(±)	5.17	110.31	59.397
C.D. (0.05)	15.17	323.56	174.22
K_1	149.97	2739.03	1330.92
K_2	216.60	3612.08	1609.97
K_3	233.69	2746.56	1616.77
S.Em(±)	4.48	95.53	51.44
C.D(0.05)	13.14	280.20	150.87

1.3. Effect of boron and potassium application on potassium content of nut (mg/kg)

The result with respect to the effect of graded levels of application of boron and potassium are also presented in (Table 1) (Fig 1). The potassium content of nut was progressively increased with increase rate of soil application of boron and B2 level of boron application recorded significantly higher potassium content (2006.22 mg/kg) might be due to higher boron concentration in soil (223.36 mg/kg) (Fig 1) the treatment comprising of bunch spray also recorded significantly higher potassium content (1582.67 mg/kg) (Table 1) compared to B0 and B1 through it was recorded lower leaf potassium content.

The result pertaining to potassium content of the nut with regard to potassium application revealed that potassium content of leaves showed an increasing trend with the increase application of potassium K2 and K3 levels of potassium application recorded statistically at per nut potassium due to higher potassium content in soil as well a leaf.

Boron and potassium interaction effects on the nut potassium content showed that the treatment B2K2 observed the highest value (2032.57 mg/kg) followed by B2K1 (1791.60 mg/kg) (Table 2) (Fig 2) the treatment B0K1 recorded the lowest nut potassium.

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

Treatment	Potassium content in the soil (mg/kg)	Potassium content in the leaf (mg/kg)	Potassium content in the nut (mg/kg)
B_0K_1	182.72	2469.80	900.20
B_0K_2	150.36	3376.10	1104.20
B_0K_3	302.53	4365.77	1534.3
B_1K_1	157.65	3684.23	1110.30
B_1K_2	279.06	3313.63	1666.33
B_1K_3	186.15	3633.07	1148.70
B_2K_1	154.15	3288.20	1791.60
B_2K_2	306.86	3384.57	2032.57
B_2K_3	209.08	1634.73	1599.50
B_3K_1	105.34	1169.03	1521.60
B_3K_2	130.10	1720.32	1636.80
B_3K_3	236.99	1697.53	1589.60
S.Em(±)	8.96	191.07	102.87
C.D(0.05)	26.28	560.42	307.75

2. Interaction effect of boron and potassium application on fresh kernel weight (g) and Dry kernel weight (g) :-

2.1. 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 B_3K_2 (13.03 g) (Fig 3) produced significantly higher kernel weight and was *at par* with remaining all 10 treatments but B_2K_1 (10.18 g) (Fig 3) produced significantly lower 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.

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

Interaction effect of both minerals, the experimental data reveals that B_2K_2 (3.80 g) level shows significantly higher dry kernel weight followed by B_3K_2 (3.73 g) and B_0K_2(3.61 g) (Table 2) (Fig 3) as noticed with respect to fresh kernel weight, may be due to better combination of both nutrients and B_0K_1 level of application recorded significantly lower dry kernel weight(3.00 g) due to lower availability and ultimately reflected in dry matter accumulation.

Table 2: 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)
B_0K_1	11.34	3.00
B_0K_2	12.32	3.61
B_0K_3	12.64	3.01
B_1K_1	12.41	3.26
B_1K_2	12.74	3.01
B_1K_3	12.33	3.09
B_2K_1	10.18	3.01
B_2K_2	12.94	3.88
B_2K_3	11.84	3.11
B_3K_1	10.82	3.00
B_3K_2	13.03	3.73
B_3K_3	12.53	3.44
S.Em(±)	0.64	0.29
C.D.(0.05)	1.88	0.85

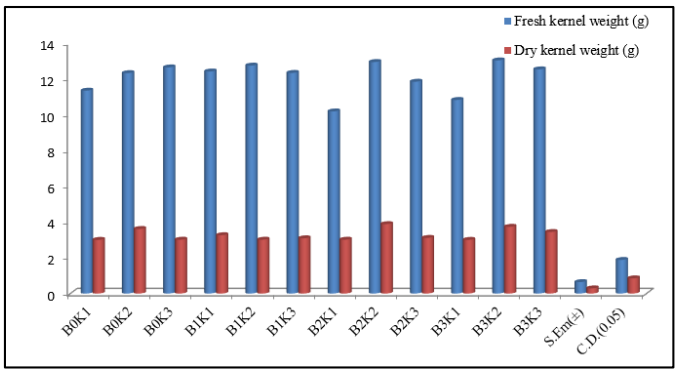

Fig 3: Interaction effect of boron and potassium application on fresh kernel weight (g) and Dry kernel weight

Conclusion

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 potassium 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 B_3K_2 performed the best with respect to fresh kernel weight and B_2K_2 performed the best with respect to dry kernel and also the individual effect and also interaction effect of both boron and potassium showed similar significant effect on increased potassium content of soil and nut of arecanut, but the potassium content in the leaf is varied comparably for soil and nut potassium content.

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

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