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The Effects of Nano Fabricated Boron and Growth Regulator on Calcium Uptake and Lodging of Rice

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ABSTRACT

The mobility of boron from outside the plant cell to inside the plant cell requires mediation by a boron polyol complex. Unless the boric acid complexes with polyol, the boron is not ready to transverse the membrane system and enter the cytosol within the plant cell. The availability of boron determines how well available calcium in soil is absorbed and transported. Calcium is immobile in the plant and is carried mainly with the water flow. Calcium is also involved with signalling potassium to open and close the stoma in plant leaves. Thus, a calcium deficiency results in poor regulation of the stomata with the result that the plant is more susceptible to wind, heat or cold stress, biotic and abiotic stress. Boron deficiency induces abnormal changes in the metabolism of the cell wall. The experiment was conducted on paddy var IET 4786 to analysis and research for the effect of nanofabricated boron and growth regulator on calcium uptake and lodging.Various combination of nanofabricated boron and growth regulator were taken along with control and recommended Fertilizer dose for the crop. After application of the discussed treatment young leaf samples were collected to examine the boron and calcium content of the leaf by Atomic Absorption Spectroscopy. 75 ml nano boron and 20ppm NAA and T7 70% RFD,0. 75 ml nano boron and 20ppm NAA and T7 70% RFD shows the maximum result in case of analysis of the he effects of nano fabricated boron and growth regulator on calcium uptake and lodging of rice. Those supplied with consistent, incremented, balanced blends of nutrients and selective microbial activators will always form superior growth, yields and quality boron and calcium travel around the plant in a similar way. Effect of nano boron helps in calcium uptake and enhance translocation in the plants.

INTRODUCTION

Rice is grown throughout the planet and most important staple food crop within the world. India has the most important area under rice cultivation but almost three decades since the revolution, the rice yield rate of growth was approximately 2.5% per annum. But the planet's population is estimated to be 8.2 billion within the year 2030 and therefore the global rice demand will rise to about 765 million tons(FAO, 2016). The important rice growing states in India are West Bengal, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, Bihar,Punjab, Orissa and Karnataka. Area-wise, West Bengal is the 13th among 35 states and Union Territories of India having higher population density per unit area and lowest capita-1 acreage among the states of the country. In West Bengal rice mainly grow in three different season i.e. Aus (autumn rice), Aman (winter rice), Boro (summer rice). West Bengal covers the highest rice cultivated area of about 5.80 m ha with the most important production of 12.64 MT. Recommended doses of fertilizers are applied to extend rice plant growth and productivity. Main fertilizers applied to rice include nitrogen, phosphorus, and potassium and sometimes micronutrients also are added in smaller amounts as essential nutrients. Fertilizers are usually directly applied to soil, and also applied on leaves as foliar spraying. The term ‘Boro’ derives from the Sanskrit word 'Borob' which suggests a special sort of rice cultivation in lowlands during November-May months. River basins, deltas are the normal area where Boro rice wants to be cultivated because during monsoon these areas are fully waterlogged and may not be drained so it's ideal settings for boro rice cultivation during winter season. Boro rice(summer rice)has come as a boon to the farmers of this region, but it's become popular only recently with the introduction of cold tolerant rice varieties. Boro rice produces more yields than the kharif rice within the same ecology. In fact, the yields recorded from experiments, both at research stations and at farmer’s fields show that yields from boro rice are manifolds compared to kharif rice. 'IET 4786(Shatabdi)’ is one of the most important among released varieties, have recorded yields between 4-6 t/ha. Boron is an important plant nutrient. Its deficiency accounts for an enormous loss in crop production worldwide. Boron is out there in soilor applied as sodium tetraborate (Borax) or boric acid, octaborate. Boron, however, is usually considered to be phloem immobile or to possess only limited phloem mobility in higher plants. The mobility of boron from outside the plant cell to inside the plant cell requires mediation by a boron polyol complex. Unless the boric acid complexes with polyol, the Boron isn't ready to transverse the membrane system and enter the cytosol within the plant cell. Polyol compounds, however, aren't present sufficiently or totally absent in higher plants. Thus, in most crops (which lack polyol), Boron's mobility is restricted through phloem vascular tissues and Boron fertilization is restricted. Thus, there's a requirement for a more efficient Boron fertilization method in higher plants.

For bororice(summer rice) there is a challenge of lodging before and after flowering leads to massive loss in yield due to seasonal storms(kalbaishaki) or cyclones. To recover this problem calcium has the great role.Calcium interacts with pectin to generate calcium pectate, which is an important component of the cell wall.It also encourages the activity of soil bacteria that are involved in the fixation of free nitrogen or the synthesis of nitrates from organic nitrogen sources.It is also required for the formation of a strong root system because calcium cannot be transferred once it has been incorporated into cell walls, it is critical to have a sufficient supply when new cells form. As a result, having a sufficient supply will help the crop look nice while also protecting it from biotic and abiotic damage and protect the plant from lodging, Root function is harmed by calcium shortage.The availability of boron determines how well available calcium in soil is absorbed and transported.Calcium is immobile in the plant and is carried mainly with the water flow. This is why it accumulates in the leaf. However, when calcium is in the soil solution, it readily leaches therefore it tends to be particularly deficient in the higher rainfall zones, or where irrigation is poorly managed. Since plants are unable to utilise calcium from older leaves for growth, a deficiency is often first observed in the growing points and youngest leaves. Roots are usually affected before the tops; with both roots and tops exhibiting die back of the growing point. Where calcium deficiency is moderate to acute, root growth is markedly impaired and plants become susceptible to root-rot infection.Calcium is also involved with signalling potassium to open and close the stoma in plant leaves. Thus, a calcium deficiency results in poor regulation of the stoma with the result that the plant is more susceptible to wind, heat or cold stress. Regarding the similarity of B functions to other plant nutrients, Ca-B relationship is out standing. Both elements play an important role in cell wall metabolism and are required for auxin transport process (Dela-Fuente et al., 1986). BoroNdeficiency induces abnormal changes in the metabolism of the cell wall. However, in tomato B deficiency slightly increased Ca uptake but inhibited Ca translocation to the upper leaves (Yamauchi et al., 1986). Boron tends to keep Ca in a soluble form within the plant: effects are probably on a tissue basis rather than on a cellular basis (Wallace, 1961). The results of Ramon et al. (1990) also suggested that B deficiency has a specific effect on Ca translocation and incorporation into an insoluble form i.e. as cell wall components. It is well known that the toxic effects of B may be reduced or prevented by adding Ca to soils. These phenomena have been ascribed both to reactions with in soil and to metabolic processes in plants (Kabata-Pendias and Pendias, 1992). Chatterjee et al. (1987) studied the metabolic changes associated with B-Ca interaction in cereals and found when both B and Ca were deficient together the activity of starch, phosphorylase, ribonuclease and polyphenol oxidase markedly increased, suggesting that the deficiency of both elements was associated to metabolic changes in paddy

MATERIALS & METHOD

Figure-1

Rice variety used in the experiment was Shatabdi(IET 4786).Seeds are collected from Chinsurah Rice Research Station .The plants are semidwarf and photoperiod non-selective with stiff straw, broad and erect leaves and good tillering habit. The varieties take 110- 120 days from seed to seed duration in rabi season. Leaves remain green till soft dough stage. Grains are long length, narrow width and long slender shape and of good cooking quality. The experiments were laid out in Randomized Block Design (RBD) having three replications with 3m X 4m plot size. Total area under experiment was 720m2. Bunds of 0.5 m wide were kept between the plots to prevent lateral seepage of water & path for inspection. Irrigation channel of 1m .In replication the numbers of plots were eleven. . Row to row spacing was 20 cm & plant to plant spacing was 15 cm. Calcium concentration of the soil was 49mg/kg after soil testing in Soil testing laboratory in Govt of West Bengal. The below treatments were prepared and sprayed at 25 DAT.T1 is control where no fertilizer was used only cow dung was added at the time of ploughing at the rate of 200 kg /acre . In T2 treatment with 0.25 ml. Nano Boron, root dipping of seedlings of seedling and foliar spray at 35 day was done. In T3 treatment with 0.25 ml nano boron and 20ppm NAA, root dipping of seedlings before transplanting and foliar spray at 35 days was done. T4 treatment with 70% RFD, 0.25 ml nano boron and 20ppm NAA, root dipping of seedling and foliar spray at 35 days was done with for 2 hours and the RFD was applied as top dressing at about 35 DAT. In T5 treatment with 0.75 ml. Nano Boron, root dipping of seedlings of and foliar spray at 35 day was done. In T6 treatment with 0.50 ml nano boron and 20ppm NAA, root dipping of seedlings before transplanting and foliar spray at 35 days was done. T7 treatment with 70% RFD,0.50 ml nano boron and 20ppm NAA, root dipping of seedling and foliar spray at 35 days was done with for 2 hours and the RFD was applied as top dressing. In T8 treatment with 0.75 ml. Nano Boron root dipping of seedlings of seedling and foliar spray at 35 day was done and fertilizer at recommended dose was applied at about 35 DAT as top dressing. In T9 treatment with 0.75 mlnano boron and 20ppm NAA, root dipping of seedlings before transplanting and foliar spray at 35 days. T10 treatment with 70% RFD, 0.75 ml nano boron and 20ppm NAA, root dipping of seedling and foliar spray at 35 days was done with for 2 hours and the RFD was applied as top dressing at about 35 DAT.In case of T11 where recommended fertilizer dose was applied at the rate of 120:60:60 N, P2O5 and K2O kg ha-1.After application of the discussed treatment young leaf samples were collected to examine the boron and calcium content of the leaf by Atomic Absorption Spectroscopy. In case of Boron analysis curcumin based colorimetric method was applied. The extracted B in the filtered extract is determined by the azomethine-H (Figure 1)followed by Atomic Absorption Spectroscopy for analysis of Calcium. Post harvestdatas were collected to show case the minimum non lodging affected plants and their yield.

RESULTS & DISCUSSIONS

Table 1:Effect of different concentration of nano fertilizer and growth regulator (NAA)on leafCa concentration(%)of boro rice (Var.*Shatabdi- IET 4786*) at40 days.

Treatment No	**Treatments Details**	**Year 1(2017)**	**Year2(2018)**	**Year 3(2019)**
T1	Control	0.45	0.49	0.453
T2	0.25ml. NanoBoron	0.453	0.467	0.47
T3	0.25ml. Nano Boron+ 20ppmNAA	0.53	0.517	0.527
T4	0.25ml. Nano Boron+ 20 ppm NAA +70%RFD	0.48	0.49	0.48
T5	0.50ml. NanoBoron	0.53	0.51	0.463
T6	0.50ml. Nano Boron+ 20ppmNAA	0.523	0.44	0.473
T7	0.50ml. Nano Boron+ 20 ppm NAA +70%RFD	0.533	0.493	0.493
T8	0.75ml. NanoBoron	0.537	0.48	0.483
T9	0.75ml. Nano Boron+ 20ppmNAA	0.533	0.44	0.441
T10	0.75ml. Nano Boron+ 20 ppm NAA +70%RFD	0.53	0.533	0.517
T11	100%RFD	0.5	0.503	0.51
CD@5%		**0.03**	**0.09**	**0.09**

From the above stated table a significant effect of Ca content can be seen by the different treatments of different concentrations of Nano fabricated boron micronutrient with growth regulator. The content of Ca varied from 0.45 to 0.53 .The maximum Calcium content (0.53) was found under the treatment T9 (0.75 ml Nano Boron + 20 ppm NAA) and(T10 (0.75 ml. Nano Boron + 20 ppm NAA + 70% RFD) followed by T8 (0.5 ml. NanoBoron+20ppmNAA+70%RFD).The lowest concentration was observed under the treatmentofT1orcontrolled(Graph 1)

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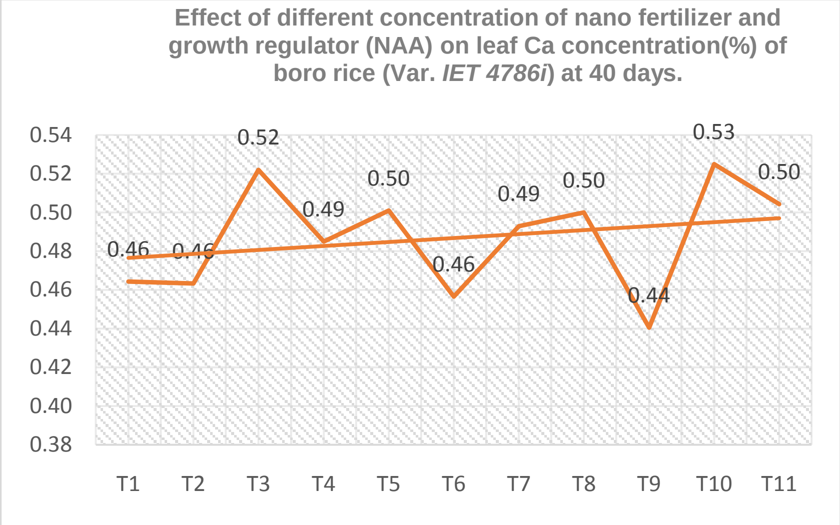


Graph-1

Figure-2

Table 2: Effect of different concentration of nano fertilizer and growth regulator (NAA)onpanicle weight(gm)of boro rice(Var.*IET 4786)*

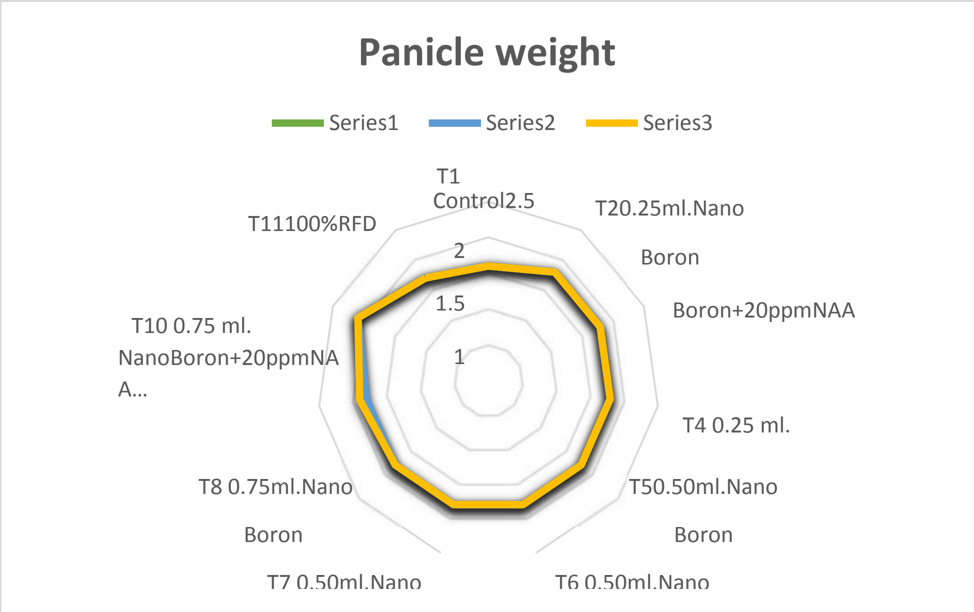
Treatment No	Treatmentdetails	Year1(2017)	Year2(2018)	Year3 (2019)
T1	Control	1.6	1.6	1.6
T2	0.25 ml.NanoBoron	1.8	1.8	1.8
T3	0.25 ml.NanoBoron+20ppm NAA	1.8	1.8	1.8
T4	0.25 ml. Nano Boron + 20 ppm NAA + 70%RFD	1.8	1.8	1.8
T5	0.50 ml.NanoBoron	1.8	1.8	1.8

T6	0.50 ml.NanoBoron+20ppm NAA	1.8	1.8	1.8
T7	0.50 ml. Nano Boron + 20 ppm NAA + 70%RFD	1.8	1.8	1.8
T8	0.75 ml.NanoBoron	1.8	1.8	1.8
T9	0.75 ml.NanoBoron+20ppm NAA	1.8	1.8	1.9
T10	0.75 ml. Nano Boron + 20 ppm NAA + 70%RFD	2.1	2.1	2.1
T11	100% RFD	1.7	1.7	1.7
CD @ 5%		0.02	0.02	0.02

Figure-3

Figure-4

Series1-Year 1 Series2-Year2Series 3-Year3



Graph-2

From the above stated table a significant effect of panicle weight can be seen by the different treatments of different concentrations of Nano fabricated boron micronutrient with growthregulator. Panicle weight varied from one treatment to another in a range between 1.6 to 1.7gms.T10 had the highest panicle weight followed by the treatments like T6,T5,T 8.The lowest testweight was observed in the test weight of T1 followed by T10 having a average Critical difference of value is 0.02.

Table 3:Effect of different concentration of nano fertilizer and growth regulator (NAA)on1000 grainweight (Test Weight)of bororice(*IET 4786*).

Treatment No	Treatmentsdetails	Year1(2017)	Year2(2018)	Year3(2019)
T1	Control	18.1	18	18
T2	0.25ml.NanoBoron	18.3	18	18.3
T3	0.25ml.NanoBoron+20 ppmNAA	17.8	17.6	17.9
T4	0.25ml. NanoBoron +20 ppmNAA+70% RFD	19	18.9	19.1
T5	0.50ml.NanoBoron	18	17.9	17.8
T6	0.50ml.NanoBoron+20 ppmNAA	17.8	17.8	17.8
T7	0.50ml. NanoBoron +20 ppmNAA+70% RFD	18.7	18.6	18.5
T8	0.75ml.NanoBoron	17.7	17.8	17.9
T9	0.75ml.NanoBoron+20 ppmNAA	17.9	18	17.8
T10	0.75ml. NanoBoron+20 ppmNAA+70% RFD	22.1	22.1	22.1
T11	100%RFD	18.9	18.8	18.8
CD@5%		**0.12**	**0.28**	**0.35**

1000 grain Weight(Test weight) :

1000 grain weight is directly related to the yield attributing character.Itis used as an indicatorof general grain quality and is a measure of grain bulk density.From the above stated table a significant effect of test weight can be seen. the test weight variedfrom one treatment to another in a range between 17 to 22 gms.T10 (0.75ml. NanoBoron+20 ppmNAA+70% RFD) had the highest test weightfollowed by the treatments like T6,T5,T 8.The lowest test weight was observed in the test weightofT1 followed by T10(control having a averageCritical differenceof value

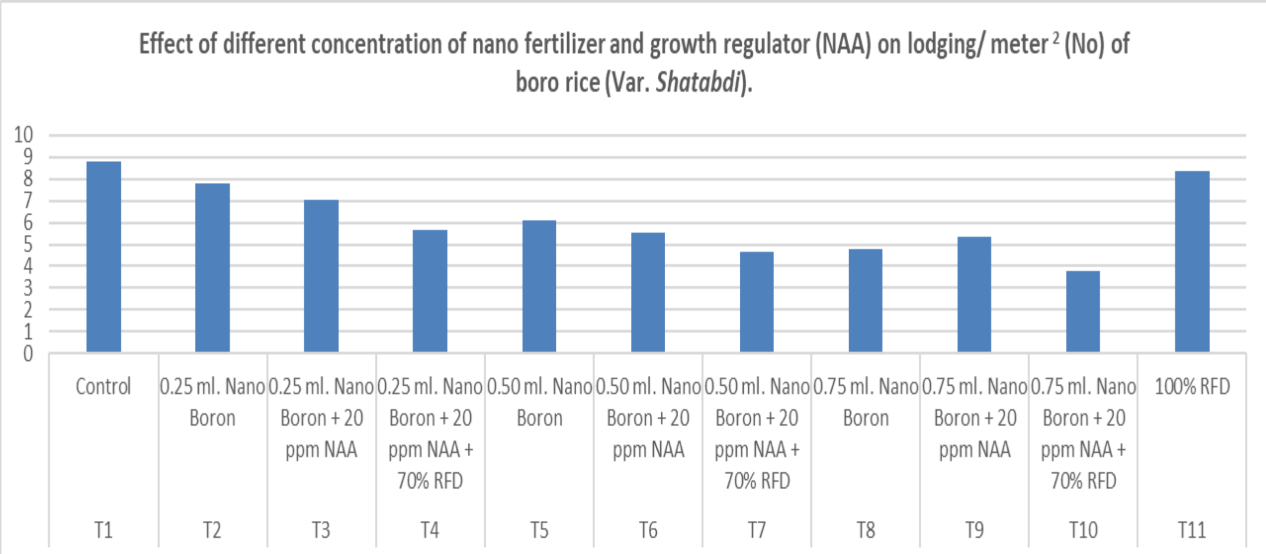
Table 4: Effect of different concentration of nano fertilizer and growth regulator (NAA)on lodging/ meter ^{2} (No) ofbororice(Var.*IET 4786*).

SLNo	Treatments	Year1 (2017)	Year2 (2018)	Year3(2019)
T1	Control	7	6.1	13.3
T2	0.25ml. Nano Boron	5.8	6.2	11.4
T3	0.25ml. Nano Boron +20 ppmNAA	6	5.9	9.2
T4	0.25 ml. Nano Boron + 20 ppm NAA + 70%RFD	3.8	4.1	9.1
T5	0.50ml. Nano Boron	4.1	4	10.2
T6	0.50ml.Nano Boron +20ppmNAA	3.2	3.6	9.8
T7	0.50 ml. Nano Boron + 20 ppm NAA + 70%RFD	2.9	3.1	7.9
T8	0.75ml. Nano Boron	3	3.1	8.3
T9	0.75ml.Nano Boron +20ppmNAA	4	4.3	7.8
T10	0.75 ml. Nano Boron + 20 ppm NAA + 70%RFD	2.2	2.1	7
T11	**100 % RFD**	**6**	**6.9**	**12.1**
CD @ 5 %		**0.04**	**0.06**	**0.07**
SE (diff)		**0.01**	**0.02**	**0.03**

Numbers of Lodging plants /m^2

Figure-5

From the above stated table a significant effect is found in case of lodging plants after using different treatments of different concentrations of Nano fabricated boron micronutrient with growth regulator .In all consecutive year shows the minimum lodging effect in case T10 (0.75 ml. Nano Boron + 20 ppm NAA + 70%RFD) followed by T7 (0.5 ml. Nano Boron + 20 ppm NAA + 70% RFD).A significant difference of lodging effect was found in the year 2019 . The crop was exposed to the cyclone Fani on 26th April and the promising result was found in terms of non-lodging plants/meter^2**.** It is concluded that there is a significant role of nano fabricated boron in calcium uptake and strengthen cell wall,this leads to with strand the plants from lodging even if strong cyclone comes.



Graph-3

The following observations are found:

1. Increased calcium content in case of treatment T10 with 70% RFD, 0.75 ml nano boron and 20ppm NAA, foliar spray at 40 days was done.
2. Less number of lodging plants were observed in case of treatments applied T10 with 70% RFD, 0.75 ml nano boron and 20ppm NAA and T7 70% RFD,0.50 ml nano boron and 20ppm NAA(Figure-4)
3. Post harvestresults(Figure-3) were collected for analysis of moisture content of the seed and test weight in comparison with calcium content. Promising results(Figure -4) were found in case of T10 with 70% RFD, 0.75 ml nano boron and 20ppm NAA and T7 70% RFD,0.50 ml nano boron and 20ppm NAA.

CONCLUSION

By the above experiment it is concluded that Nano Boron and growth regulator has significant effect in uptake of Calcium and thus a way there are clear evidence of less lodging , better grain weight and higher calcium content in the leaf. Calcium concentration in the soil solution is present about 10 times greater than that of K concentration. In-spite of presence of greater concentration of Ca in the soil solution, its uptake by plants is lower than that of K as the capacity of the uptake of Ca is limited to only by young root tips. Calcium and boron are the rebar of the plant. Tissues will form with deficiencies of both elements. But, all tissues are not formed equal. Those supplied with consistent, incremented, balanced blends of nutrients and selective microbial activators will always form superior growth, yields and quality Boron and calcium travel around the plant in a similar way.The uptake of Ca is not as efficient as other nutrients.The apoplastic elements Ca2+ and B have been named. This is mostly due to their presence in cell walls; nonetheless, it has become clear that these two components play an important role in maintaining cell wall integrity by binding to pectic polysaccharides. There are two ways Ca is absorbed into the plants, at very low levels it is controlled metabolically and at very high levels diffusion takes over. Effect of nano boron helps in calcium uptake and enhance translocation in the plants. Helps is secondary, downward movement with the help of ion exchange method.

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