ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 4 , April 2017

Effects of Seed Priming with BORON and RHIZOBIUM INOCULATIONON Yield and Yield Components of SOYBEAN *(Glycine max L.)*

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ABSTRACT: The lower yield of soybean in Nepal has been attributed to the improper management of soil moisture, nutrient and wrong selection of varieties. The experiment was carried out to see the effects of seed priming with boron and rhizobium inoculation on yield and yield components of soybean (Glycine max L.) under the hot and moist sub-tropical agro-ecological condition of Birgunj during July-November 2015. Two varieties of soybean i.e. Puja, Ransom and one pipeline genotype PK-7394 were tested under Control, Boron (235 mg borax/kg), Inoculum (Rhizobium japonicum) and Boron (235 mg borax/kg) and Rhizobium. The experiment was carried out in Randomized Complete Block Design (RCBD) in three replications. The Seed priming with boron followed by Rhizobium inoculation significantly increased yield (2.28 t ha^{-1}), fruiting branches $plant^{-1}$ (13.33) and harvest index (31.23%), whereas maximum pods $branch^{-1}$ (51.06) and test weight (85.02g) were obtained from those seeds that were primed with boron but not inoculated with Rhizobium strain. Among the three varieties, the highest yield (2.46 t ha^{-1}) along with superior yield components i.e. fruiting branches $plant^{-1}$ (13.42) and pods $branch^{-1}$ (50.88) was recorded from pipeline genotype PK-7394, whereas, maximum test weight (83.88g) and HI (31.06%) was obtained from Puja variety. The maximum Benefit: Cost ratio (i.e.2.14) was observed in pipeline genotype (PK7394) and under combine application of boron and rhizobium (1.98) whereas, least performance was observed in case of Ransom variety.

KEYWORDS: Boron, Rhizobium, Soybean, Yield

I. INTRODUCTION

Soybean (Glycine max (L.)), a leading source of edible vegetable oil and protein for both humans and animals, has the potential to nourish humans worldwide in the near and distant future (Hartman *et al*., 2011).Its seed has 40-42% of high quality protein, 18-20% oil content and some other nutrient content such as iron(Fe), Calcium(Ca) and glycine (Devi *et al*., 2012). Malik et al. (2006) depicted that soybean oil consisted of 85% cholesterol free unsaturated fatty acids. Because of its high nutritional value and myriad form of uses, it is recognized as 'Golden Bean.

In Nepal the average yield of soybean is 1.189 t/ha (MOAD 2013/14) which is three times less than average productivity of world i.e.3t/ha (FAOSTAT 2013). The production and productivity of soybean is lower in Nepal due to the improper management of soil moisture, nutrient and wrong selection of location specific varieties. Soybean yield can be significantly increased by the application of optimum dose of boron (Devi *et al*., 2012; Sarkar *et al*., 2002), and rhizobium inoculation (Tahir *et al*., 2009).

II. OBJECTIVES

- To study the effect of seed priming with boron and rhizobium inoculation on different varieties of soybean.
- To analyze the growth, yield and yield attributing characteristics of soybean.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

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III . MATERIALS AND METHODS

The experiment was carried out in Birgunj, Nepal to evaluate the effect of seed priming with boron and rhizobium inoculation on growth, yield and yield component of different varieties of soybean. In this experiment two varieties of soybean i.e. puja and ransom and one pipeline genotype i.e. PK7394 was used. The treatments comprised varieties and different nutrient management practices (i.e. control, boron, rhizobium, boron and rhizobium). Seeds were sown during 1st July,2015 after priming them with boron @235mg borax/kg for 12 hours before sowing. At the time of sowing seeds were inoculated with strain of Brady rhizobium japonicum @ 5gm/kg. The seed rate of 75kg/ha was used by maintaining row to row distance of 30 cm and plant to plant distance of 10 cm. The experiment was laid out in Randomized Complete Block Design (RCBD) with net plot size of 4 m x 3.8 m by using three replications. Fertilizer was used@ 15:40:30 kg NPK/ha +6 ton FYM/ha. The whole phosphorus and potassium was utilized at sowing time, whereas the nitrogen was applied in two equal splits, i.e. half at sowing time and remaining half at grain formation stage. The crop was harvested on 8th and 9th Nov, 2015. Date were periodically collected before and after harvest and analyzed by using SPSS, Ms-Exel and Gen Stat.

IV. RESULTS AND DISCUSSION

Table 1. Yield attributes of soybean in Birgunj, Nepal, 2015.

Nutrient management	Fruiting branches/plant	Pods/branch	Seeds/pod	Length of pod(cm)
Control	10.87[b]	48.78[b]	2.11[a]	3.89
Boron	12.22[ab]	51.06[a]	2.33	3.79
Rhizobium	12.33[a]	49.56[ab]	2.11	3.48
Boron & rhizobium	13.33[a]	50.94[ab]	2.33	3.6
LSD	1.12	1.67	Ns	Ns
Varieties				
Puja	12.33[a]	50.88[b]	2.42	3.93[a]
Ransom	10.75[b]	46.58[c]	2.25	3.71[ab]
Pk7394	13.42[a]	52.79[a]	2.00	3.47[b]
LSD (0.05)	.97	1.44	Ns	.34
CV	1.4%	.9%	2.2%	2.4%
Grand mean	12.17	50.07	2.22	3.7
Treatment means followed by common letter/letter within column are not significantly different among each other based on dmrt at 0.05				

In case of nutrient maximum fruiting branches per plant was observed under combined application of boron and rhizobium. This result was statistically at par with separate application of boron and rhizobium.Increased fruiting branch due to rhizobium inoculation might be due to symbiosis, leading to increased nodulation and resulting optimum development of yield components (Tien *et a*l.2002; Tahir *et al*., 2014). Boron application significantly increased the number of pod bearing branches per plant of soybean (Sarker*et al*., 2002). These results are similar with the finding of (Liu *et al*., 2005; Devi *et al*., 2012 and Tahir *et al*., 2014).
In case of variety maximum fruiting branches per plant are recorded from the pipeline genotype PK7394. This result was statistically at par with puja variety.

Pods/branchis one of the important yield contributing parameter that has significant contribution towards final yield. Maximum pods per branch were observed under boron application. This result was statistically at par with combined

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 4 , April 2017

application of boron and rhizobium and separate application of rhizobium. Increased number of pods per branches under boron application are recorded by (Lui*et al*., 2005) and (Devi *et al*., 2012).
In case of variety maximum pods per branch were observed in pipeline variety PK7394. Whereas, least number of pods per branch are recorded from ransom variety.

As the length of pod increases, the number of seeds per pod goes on increasing. Longest length of pod was observed in puja variety. Whereas, the shortest length was observed in pipeline variety PK7394.

Table 2. Grain yield, test weight and harvest index of soybean in Birgunj, Nepal, 2015

Nutrient management	Yield (t/ha)	Test weight(g)	HI%
Control	1.65[b]	78.16[c]	22.17[d]
boron	2.14[a]	85.02[a]	28.64[b]
Rhizobium	1.87[b]	81.82[b]	26.86[c]
Boron & rhizobium	2.28[a]	84.67[a]	31.23[a]
LSD (0.05)	.1899	.69	.89
Varieties			
Puja	2.38[a]	83.88[a]	31.06[a]
Ransom	1.108[b]	80.80[c]	21.11[c]
PK7394	2.46[a]	82.56[b]	29.52[b]
LSD (0.05)	.1645	.59	.78
CV	5.8%	.5%	1.1%
Grand mean	1.986	82.42	27.23

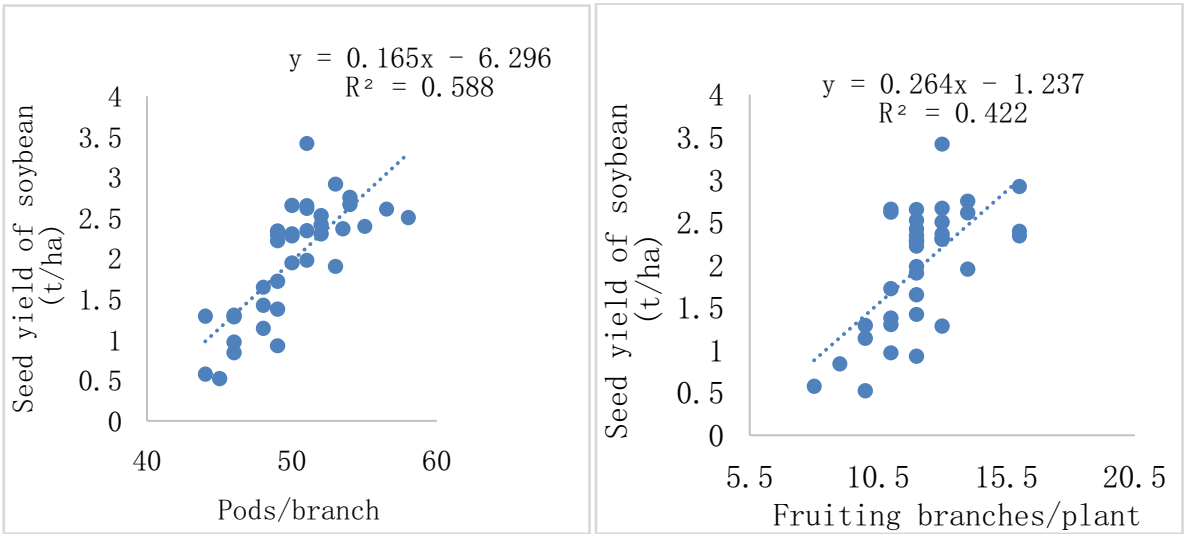

Figure 1. Linear regression equation between yield components and seed yield

Increasing grain yield is an ultimate objective of every research program. Yield is an important parameter for judging an effectiveness of any treatment. Maximum yield was recorded from combined application of boron and rhizobium. This result was statistically at par with boron application alone. Increased yield under boron and rhizobium inoculation might be due to positive influence of boron on cell division, hormonal regulation, starch and sugar formation and

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 4 , April 2017

increased nodulation respectively (Tahir *et al*., 2014).This findings was in accordance with the finding made by (Lui*et al*., 2005) and (Devi *et al*., 2012). In case of variety higher yield was recorded in pipeline genotype PK7394. This result was statistically at par with puja variety. Lowest yield was obtained from ransom variety.

Test weight(1000 seed weight)is an important yield component, contributing to final grain yield. Maximum 1000 seed weight was recorded in boron application. This result was statistically at par with combined application of boron and rhizobium. An increased seed weight might be due to positive influence on cell division, hormonal regulation, sugar and starch formation which increased the weight as well as size of seed (Tahir *et al*., 2014). In case of variety maximum 1000 seed weight was recorded in puja variety. Whereas, minimum weight was recorded in ransom variety.

Harvest index is an efficiency of plant to convert dry matter into grain yield.Maximum harvest index was recorded in combine application of boron and rhizobium. This increased harvest index might be due to higher grain yield. Increased harvest index under boron application was recorded by (Hussain *et al*., 2005) and (Devi *et al*., 2012).

V. CONCLUSION

From this field experiment, it is concluded that boron and rhizobium has positive influence on vital physiological functioning of plant. Seed priming with boron and rhizobium inoculation significantly improved growth, yield components and final seed yield of soybean. In case of variety, the lowest yield of Ransom variety signifies its unsuitability in humid sub-tropical agro-ecological zone of Parsa. Almost consistent yield was obtained in Puja variety under all treatments. Pipeline genotype PK7394 was found superior among all the tested varieties.

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