Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(4): 1138-1141
Received: 15-05-2018
Accepted: 20-06-2018

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Effect of yield and benefit cost ratio and protein content of Greengram (*Vigna radiata*) at different zinc levels and frequency of boron levels

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Abstract
A field experiment was conducted during *kharif* season, 2017 at the Crop Research Farm, Department of Agronomy, SHIATS, Allahabad (U.P.) to concluded the response of different zinc levels and frequency of boron levels on yield and benefit cost ratio and protein content in *kharif* Greengram (*Vigna radiata* L.) in Randomized Block Design with twelve treatments replicated thrice. Among the different zinc levels and frequency of boron levels under in treatment T_{12} *i.e.*,20 & 35 DAS (0.2% foliar spray) of boron +5.0kg ha^{-1} of zinc recorded maximum grain yield (2.18t ha^{-1}), stover yield (2.96t ha^{-1}), harvest index (45.14%), protein content (24.56%) whereas the lowest values were recorded in Grain yield(1.46t ha^{-1}), stover yield (1.83t ha^{-1}), Harvest index (40.19%), Protein content (20.26%) in treatment T_1Control + 0kg ha^{-1}. The highest gross return (₹115630 ha^{-1}), net return (₹73933.66 ha^{-1}) and b:c ratio (1:2.69) were recorded in T_{12} *i.e.*,20&35DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc whereas the lowest values were recorded in Gross return (₹60230 ha^{-1}), Net Return (₹20543.4 ha^{-1}) and B:C ratio (1:1.51) in treatment T_1 Control + 0kg ha^{-1}.

Keywords: benefit cost ratio, Greengram, *Vigna radiata*, frequency of boron

Introduction
Greengram locally called as moong or mung [*Vigna radiata* (L.) Wilczek]. It belongs to the family leguminaceae so it has the capacity to fix atmospheric nitrogen. It's one of the important *kharif* pulse crops of India which can be grown as catch crop between *rabi* and *kharif* seasons. India alone accounts for 65% of its world acreage and 54% of the total production. It is grown on about 3.50 m ha in the country mainly in Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Orissa and Bihar. A phenomenal increase in area, production and productivity has occurred since 1964-65. The area has increased from 1.99 million ha in 1964-65 to 3.54 million ha in 2010- 2011. The production has increased from 0.60 million tonnes to 1.81 million tonnes during the same period. Throughout the India, the mungbean is used for different purposes. The major portion is utilized in making dal, soup, sweets and snacks. Mungbean is an excellent source of protein (25%) with high quality of lysine (460 mg/ g) and tryptophan (60 mg /g). It also has remarkable quantity of ascorbic acid when sprouted and also have riboflavin (021 mg/ 100 g) and minerals (3.84 W 100 g). The total area under pulses is 23.63 m ha with an annual production of 14.76 M tonnes in the country. In India green gram occupies 3.4 million hectare area and contributes to 1.4 million tonnes in pulse production. Mungbean contributes 14% in total pulse area and 7% in total pulse production in India. The low productivity of mungbean may be due to nutritional deficiency in soil and imbalanced external fertilization (Awomi *et al.*, 2012) [1].

The essential role of zinc has been established as a component of several enzymes concerned with carbohydrate and nitrogen metabolism, in addition to its involvement directly or indirectly in regulating the various physiological processes of plants. Zinc application contributed in increase in seed yield probably owing to its influence on auxin synthesis, nodulation and nitrogen fixation, which promoted plant growth and development, there by favourably influencing grain yield. (Sharma *et al.*, 2010) [7]

Boron is mainly required for reproduction of plant and germination of pollen grain. Primary role is concerned with Ca metabolism, keeps Ca in soluble form within the cell and act as regulator of K/Ca ratio, constituent of cell membrane and essential for cell division. It is also primarily needed to maintain the growth of apical growing point.

Materials and Methods

Field experiment was conducted during *kharif* season2017 at Crop Research Farm, Sam Higgin bottom University of Agriculture, Technology and Sciences, Allahabad. The experimental site is located at 25.4358^0 N latitude, 81.8463^{0}E longitude and at an 98m altitude of above mean sea level. The soil of the experimental area was sandy loam with pH 7.6, low in organic carbon 0.230%, available P (9.4 kg ha^{-1}) and available K (187 kg ha^{-1}), available zinc (0.88ppm), available B (0.24ppm). A recommended greengram variety (PDM-139) was chosen for the study. The experiment was laid out in Randomized Block Design (RBD) with two factor different levels of zinc (0.0, 2.5 and 5kg ha^{-1}) and frequency levels of boron [no application, 20DAS, 35DAS 20 & 35 DAS of 0.2% foliar spray of borax] with twelve treatments combination on a plot size of 3 x 3 m2. Before sowing, line were formed in the field as the spacing in treatments. *kharif* greengram was sown in line and covered with the soil. Greengram seeds were hand dibbled. The total quantity of nitrogen, phosphorus and potassium as per treatment in the form of Urea (46%), single super phosphate (16%) and MOP (60%) respectively were applied below the seeds at the time of sowing and 0.2% solution of borax was prepared and sprayed at 20 and 35 DAS. All the agronomic practices were carried out uniformly to raised the crop. For taking data on yield and yield components on greengram five plants were selected randomly in each plot. All the yield and benefit cost ratio and protein content were recorded using standard procedure and grain yield was calculated at 12% moisture content.

Table 1: Effect of foliar spray of boron and different levels of zinc on yield and yield attributes of Greengram:

Treatment No.	Treatments Combination	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
T_1	Control + 0kg ha^{-1}	1.46	1.83	40.19
T_2	Control + 2.5kg ha^{-1}of zinc	1.59	2.04	43.50
T_3	Control + 5.0kg ha^{-1}of zinc	1.69	2.36	41.56
T_4	20DAS(0.2% foliar spray) of boron+0kg ha^{-1}of zinc	1.78	2.46	41.96
T_5	20DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	1.88	2.69	40.95
T_6	20DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	2.16	2.90	42.69
T_7	35DAS(0.2% foliar spray) of boron+0kg ha^{-1}	1.74	2.43	41.68
T_8	35DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	1.86	2.68	40.96
T_9	35DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	1.85	2.25	44.03
T_{10}	20&35DAS(0.2% foliar spray) of boron+0kg ha^{-1}	1.85	2.25	45.04
T_{11}	20&35DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	2.00	2.79	41.79
T_{12}	20&35DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	2.18	2.96	45.14
	F- test	S	S	NS
	S. Ed. (±)	0.16	0.10	2.44
	CD. (P = 0.05)	0.33	0.20	-

Table 2: Effect of zinc levels and frequency of boron levels protein content (%) of Greengram

Treatment No.	Treatments Combination	Protein content (%)
T_1	Control + 0kg ha^{-1}	20.26
T_2	Control + 2.5kg ha^{-1}of zinc	20.36
T_3	Control + 5.0kg ha^{-1}of zinc	21.70
T_4	20DAS(0.2% foliar spray) of boron+0kg ha^{-1}of zinc	22.43
T_5	20DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	22.68
T_6	20DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	23.02
T_7	35DAS(0.2% foliar spray) of boron+0kg ha^{-1}	23.28
T_8	35DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	23.85
T_9	35DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	22.30
T_{10}	20&35DAS(0.2% foliar spray) of boron+0kg ha^{-1}	22.23
T_{11}	20&35DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	23.23
T_{12}	20&35DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	24.56

Table 3: Effect of cost of cultivation foliar spray of boron and different levels of zinc on economics of Greengram

S. No.	Particulars	Unit	Quantity	Rupees (₹)	Cost (₹ ha^{-1})
A.	Land preparation				
1	Ploughing	Hours	3	600	1800
2	Disc harrowing	Hours	3	600	1800
3	Layout preparation	Labours	8	300	2400
B.	Fertilizer application				
1	Urea (46% N)	Kg	43.4	7	308.8
2	SSP (16% P_2O_5)	Kg	375	8	3000
3	MOP	Kg	33.3	10	333
C.	Seed & Sowing				
1	Seed	Kg	16	120	1920
2	Labour for sowing	Labour	5	300	1500
D	Intercultural Operation				
1	Thinning and weeding	Labours	10	300	3000
E	Irrigation				
1	Tube well (irrigation)	Hours	7	100	700

2.	Labours for irrigation	Labour	3	300	900
F	Plant Protection				
1.	Monocrotophos	ML	50	160	160
2.	Labours for foliar spray of boron	Labours	6	300	1800
G	Harvesting				
1.	Labours for 1st pod picking	Labours	12	300	3600
2.	Labours for 2nd pod picking	Labours	10	300	3000
H	Rental value of land	Months	3	1000	3000
I	Supervision charges	Months	3	1500	4500
	Total cost of cultivation (₹ ha^{-1})				39686.6

Table 3.1: Effect of foliar spray of boron and different levels of zinc on variable cost and common cost of Greengram

No.	Treatment combinations	Boron		Zinc		fixed cast	variable cost (₹ha^{-1})	Interest	Cost of cultivation (₹ ha^{-1})
		Kg ha^{-1}	Amount	Kg ha^{-1}	Amount				
T_1	Control + 0kg ha^{-1}	0.00	000	0.00	0.00	37796.8	37796.8	1889.84	39686.6
T_2	Control + 2.5kg ha^{-1}of zinc	0.00	000	7.57	757	37796.8	38553.8	1927.69	40481.4
T_3	Control + 5.0kg ha^{-1}of zinc	0.00	000	15.14	1514	37796.8	39310.8	1965.54	41276.3
T_4	20DAS(0.2% foliar spray) of boron+0kg ha^{-1}of zinc	0.50	200	0.00	0.00	37796.8	37996.8	1899.84	39896.64
T_5	20DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	0.50	200	7.57	757	37796.8	38753.8	1937.69	40691.4
T_6	20DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	0.50	200	15.14	1514	37796.8	39510.8	1975.54	41486.34
T_7	35DAS(0.2% foliar spray) of boron+0kg ha^{-1}	0.50	200	0.00	0.00	37796.8	37996.8	1899.84	39896.64
T_8	35DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	0.50	200	7.57	757	37796.8	38753.8	1937.69	40691.49
T_9	35DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	0.50	200	15.14	1514	37796.8	39510.8	1975.54	41486.34
T_{10}	20&35DAS(0.2% foliar spray) of boron+0kg ha^{-1}	1.00	400	0.00	000	37796.8	38196.8	1909.84	40106.64
T_{11}	20&35DAS(0.2% foliar spray) of boron+2.5kg ha^{-1} of zinc	1.00	400	7.57	757	37796.8	38953.8	1947.69	40901.49
T_{12}	20&35DAS(0.2% foliar spray) of boron+5.0kg ha^{-1} of zinc	1.00	400	15.14	1514	37796.8	39710.8	1985.54	41696.34

Zinc = ₹100 kg and Boron = ₹ 400 kg

Table 3.2: Effect of foliar spray of boron and different levels of zinc on economics of Greengram

Treatments No	Treatment combinations	Cost of Cultivation (₹t ha^{-1})	Gross return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C ratio
T_1	Control + 0 kg ha^{-1}	39686.6	60230	20543.4	1.51
T_2	Control + 2.5 kg ha^{-1}of zinc	40481.4	65640	25158.6	1.62
T_3	Control + 5.0 kg ha^{-1}of zinc	41276.3	69960	28683.7	1.69
T_4	20 DAS (0.2% foliar spray) of boron+0 kg ha^{-1}of zinc	39896.64	73660	33763.36	1.84
T_5	20 DAS (0.2% foliar spray) of boron+2.5 kg ha^{-1} of zinc	40691.4	77890	37198.6	1.91
T_6	20 DAS (0.2% foliar spray) of boron+5.0 kg ha^{-1} of zinc	41486.34	89300	47813.66	2.15
T_7	35 DAS (0.2% foliar spray) of boron+0 kg ha^{-1}	39896.64	72030	32133.36	1.80
T_8	35 DAS (0.2% foliar spray) of boron+2.5 kg ha^{-1} of zinc	40691.49	77080	36388.51	1.89
T_9	35 DAS (0.2% foliar spray) of boron+5.0 kg ha^{-1} of zinc	41486.34	76250	34763.66	1.83
T_{10}	20 & 35DAS (0.2% foliar spray) of boron+0 kg ha^{-1}	40106.64	76250	36143.36	1.90
T_{11}	20 & 35DAS (0.2% foliar spray) of boron+2.5 kg ha^{-1} of zinc	40901.49	82720	41818.51	2.02
T_{12}	20 & 35DAS (0.2% foliar spray) of boron+5.0 kg ha^{-1} of zinc	41696.34	115630	73933.66	2.69

Sale price of grain ₹ 40 kg^{-1}, sale price of Stover ₹ 1 kg^{-1}

Results and Discussion

Effect on yields and yield attributes

The grain yield (2.18 t ha^{-1}) and Straw yield (2.96 t ha^{-1}), were also higher under treatment T_{12}20 & 35DAS (0.2% foliar spray) of boron+5.0 kg ha^{-1} of zinc.

The significant effect of B on number of grains might be due to the contribution of B in reducing the incidence of hollow heart in seeds and also the response of green gram to B in soils deficient in boron. Application of borax increased the number of seeds per pod in green gram. The results are in conformity with those of (Vimalan *et al.*, 2017 and Rerkasem 1990) [10, 5]. The favourable effect of various method of Zn application on straw yield of green gram might be due to its direct influence on auxin synthesis, which in tum enhance elongation process of plant development. The results are in conformity with those of (Roy *et al.*, 2013 and Ranjbar and Bahmanir 2007) [6, 4].

Effect on protein content and economics of Greengram

Among the treatments T_{12}20 & 35DAS (0.2% foliar spray) of boron+5.0 kg ha^{-1} of zinc produced significantly higher protein content, i.e. at(24.56),economics at gross return (₹ 115630 ha^{-1}), net return (₹73933.66 ha^{-1}) and b:c ratio (1:2.69).

Zinc is an essential micronutrient for plant growth and plays an important role in the catalytic part of several enzymes its deficiency will result in stunted growth. Zn is closely related to the nitrogen metabolism pathway of plants, thus helps to increase in protein synthesis. The results are in conformity with those of Hafeez *et al.*, (2013) [2].

The probable reason for increase in economics with (0.2% foliar spray of borax) at 35 DAS, due to high level of P + 0.2% foliar spray of borax at 35DAS (pre flowering) through application of SSP and borax recorded higher net returns, B:C ratio, protein content, N and P uptake and available phosphorus in soil in field pea than that of DAP and AMF are in the findings of Singh *et al.*, (2005) [8].

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