The Andhra Agric. J 65 (1): 163-168, 2018

Effect of Calcium and Boron nutrition on YMV incidence and yield in Blackgram (*vigna mungo* (l.) Hepper).

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ABSTRACT

An experiment was carried aout at college farm of Agricultural College, Bapatla during kharif season 2015-16 to know the effect of calcium and boron nutrition on tolerance of blackgram to YMV, to find out its effective concentration in reducing disease severity, whitefly population along with improving yield parameters and yield of blackgram, present investigation was under taken with soil application of Ca (gypsum) @100, 200 and 300 $kg.ha^{-1}$ & B (borax) 1,2,3 $kg.ha^{-1}$ and also in combinations, total 16 treatments. The disease incidence, whitefly population was obtained low in 300 kg gypsum + boron 1 kg ha^{-1} . The single and combined application of Ca & B increased the yield components and yield was obtained with 300 kg gypsum + boron 1 kg ha^{-1} in both the cultivars. Number of pods $plant^{-1}$ (17.43), number of seed pod^{-1} (5.36), test weight (5.2 g) seed yield (1336.22 kg ha^{-1}) were the highest mean values obtained with treatment 300 kg gypsum + boron 1 kg ha^{-1} (S_{14}) compared with control.

Key words: *Boron, Disease incidence,Gypsum, Whitefly population and Yield.*

Mungbean yellow mosaic virus (MYMV), the most devastating viral disease is a serious problem in the cultivation of blackgram in recent years. The disease is transmitted by the whitefly (*Bemisia tabaci*) and several attempts focusing on the vector were reasonably successful over a considerable period (Kumar *et al., 2006)*. However, in recent years the management of MYMV through vector control was not effective for different reasons. Even though the sources of resistance for the virus have been identified (Singh and Awasthi, 2004), their direct use is impeded due to lack of agronomic preference.

Alleviation of the effects of virus infection in view of minimizing the losses is an alternative strategy to manage the disease. The insect-plant relationship may be affected by the application of macro / micro nutrients to crop plant as nutrient deficient plants are weak and vulnerable to incidence of disease and insect pest attack (Marschner, 1995 ; Abro *et al*., 2004; Huber and Thompson 2007). Nutrient management improves the plant health, enables the plant to tolerate the incidence and herbivory of sucking as well as of chewing typing of insect pests. A balanced nutrient supply which ensures optimal plant growth is considered optimal for plant resistance. In this context, mineral nutrition of plants can be considered as an environmental factor that can be relatively manipulated with ease.

MATERIAL AND METHODS

The field experiment was conducted at "Northern" block of Agricultural College Farm, Bapatla, on a sandy clay loam soil in *Kharif* season, 2015. The experiment was laid out in split plot design with two main treatments *i.e.,* resistant cultivar PU-31 (M_1) and susceptible cultivar LBG-623 (M_2) with sixteen treatments as subplots (S_1 : Control , S_2: 100 kg gypsum ha^{-1} , S_3: 200 kg gypsum ha^{-1}, S_4: 300 kg gypsum ha^{-1}, S_5: 1 kg boron ha^{-1} S_6: 2 kg boron ha^{-1}, S_7: 3 kg boron ha^{-1}, S_8: 100 kg gypsum + 1kg boron ha^{-1}, S_9: 100 kg gypsum + 2 kg boron ha^{-1}; S_{10}: 100 kg gypsum + 3 kg boron ha^{-1};S_{11}: 200 kg gypsum + 1 kg boron ha^{-1}, S_{12}: 200 kg gypsum + 2 kg boron ha^{-1}, $S_{13:}$ 200 kg gypsum + 3 kg boron ha^{-1};S_{14}: 300 kg gypsum + 1 kg boron ha^{-1};S_{15}: 300 kg gypsum + 2 kg boron ha^{-1};S_{16}: 300 kg gypsum + 3 kg boron ha^{-1}) in three replications. Disease incidence was recorded as per Alice and Nadarajan (2007).

$$\text{Disease Incidence (\%)} = \frac{\text{No. of plants infected in a row}}{\text{Total number of plants in a row}} \times 100$$

Estimate of Whitefly Count:

Population of whiteflies was estimated by the visual count technique (Salam *et al.*, 2009).Whitefly count was taken on the top three trifoliate leaves during the early hours of the day from five randomly selected plants in each replication of all treatments at every 15 DAS interval and averaged.

The observations on yield parameters like number of pods plant^{-1}, number of seed , pod^{-1}, test weight and seed yield plant^{-1} were taken after harvest. The data collected were subjected to statistical analysis by adopting split plot design by following the analysis of variance technique suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The data related to effect of gypsum and boron nutrition on tolerance of blackgram (*vigna mungo* (l.) Hepper) to yellow mosaic virus is presented in Table 1 and 2.

Gypsum and boron application resulted in five days delay in YMV disease incidence. The reduction in disease incidence with varied application of gypsum and boron ranged from 1.6 to 3.2 % at 30 DAS, 7.1 to 11.7% at 45 DAS and at later stages the effect was nonsignificant. The reduction in disease incidence was high with S_{14} treatment. In LBG-623 the reduction in disease incidence with application was 3.3 to 5.6% at 30 DAS and 13.3% (with S_3) at 45 DAS. With boron application it was 3.4 to 5.1% at 30 DAS and nonsignificant at 45 DAS. With gypsum + boron application it was 5.1% to 16.4% at 30 DAS ,6.9 to 24% at 45 DAS and at later stages the effect was nonsignificant. In PU-31, there was no significant reduction in disease incidence with gypsum and boron application. This indicate that there was response to gypsum and boron nutrition in YMV susceptible cultivar LBG-623 and the disease incidence and severity can be reduced through gypsum and boron nutrition . The delay in disease incidence and reduction in disease incidence percentage especially in LBG-623 could be due to reduction in whitefly population with gypsum and boron nutrition. In the present investigation gypsum and boron alone and in combination reduced the whitefly population considerably before and after the incidence of YMV. Eraslan *et al.* (2007) reported that foliar spray of gypsum from four different sources ($CaCl_2.\ 2H_2O$, $Ca(NO_3).4H_2O$, $Ca(C_2H_3O_2)_2$ and $CaNO_3.4H_2O$ + 0.05M Na EDTA) at the time of inoculation ,15 and 30 days after inoculation depressed the severity of ToMV disease by causing reduction in virus concentration in leaf tissue especially after the second and third foliar spray. Significant reduction in the severity of YMV in mungbean with boron application @ 2kg.ha^{-1} was reported by Pramanik and Ali (2001). Similar results with boron also were reported by Graham and webb, (1991) in bean against tobacco mosaic virus, in tomato against yellow leaf curl virus and by Zeshan *et al* .(2012) in urdbean against ULCV disease and with gypsum by Tu (1986) in *Phaseolus vulgaris* against alfa alfa mosaic virus.

The incidence of whitefly population was less in PU-31 (62.7% at 15 DAS, 51.8% at 30 DAS,47.3% at 45 DAS and 36.9% at 60 DAS) than in LBG-623. The percent reduction in whitefly population with application of gypsum, boron and gypsum + boron at varied levels ranged from 8.0 to 84.9, 13.4 to 56.8, 11.7 to 58.3 and 19.8to 86.2 at 15,30,45 and 60 DAS respectively. The reduction in whitefly population was high with S_{14} at 15,30,60 DAS and S_{13} at 45DAS. In PU-31, the reduction in whitefly population with gypsum application was 11.7 -70.2% at 15 DAS, 16.3% at 30DAS, 17.8-28.0% at 45 DAS and 31.8% at 60 DAS. With gypsum + boron application it was 58.5 - 93.6% at 15 DAS, 25.8- 64.1% at 30 DAS, 29.8-79.6% at 45 DAS and 31.8 to 81.1% at 60 DAS. In LBG-623, the percent decrease in whitefly population with gypsum application was 6.0-56.5,6.0-41.6,12.4-39.3 and 19.9-59.8% at 15,30,45 and 60 DAS respectively. Boron application reduced the whitefly incidence by 30.2-40.2,19.4-32.7,18.3-28.0 and 41.9-50.8% at 15,30,45 and 60DAS respectively. Gypsum + boron application reduced it by 32.3-84.6, 29.8-53.5,29.6-47.8 and 48.5-88.4% at 15,30,45 and 60 DAS respectively. The less population of whitefly in PU-31 could be due to relatively higher epicuticular wax content than in LBG-623. In the present investigation it was found that PU-31 contain 9.1% higher epicuticular wax content. Development of plant chemical defense would cause the decline in whitefly population. Gypsum and boron nutrient treatment comparatively increased the total phenols in plant and also the activity of the enzymes peroxidase and phenylalanine ammonia lyase which might be responsible for the reduced pest incidence. The reduction in whitefly population with the inclusion of gypsum (gypsum nitrate 46%) and boron (0.072% boric acid) in nutrient mixture was reported by Rasdi *et al* .(2013) in brinjal. Gogi et al. (2012) reported that the addition of boron in the nutrient management schedule of non Bt-cotton resulted in population fluctuation of whitefly upto 83.1%.

No. of pods plant^{-1} in PU-31 was 36.1% higher than LBG-623. In blackgram infected with YMV, gypsum nutrition (S_3) increased the pod number plant^{-1} by 32.8%, boron nutrition by 10.3 to 3.8% and gypsum + boron nutrition by 10.3 to 50.0 %. In resistant cultivar, pod number plant^{-1}increased by 33.8% with gypsum (V_1S_3) nutrition, 7.5 to 11.3% with boron nutrition and 11.3 to58.6% with gypsum + boron nutrition. Whereas in susceptible cultivar, it was by 30.3% with gypsum (V_2S_3) nutrition, 12.1 to 16.2% with boron nutrition and 20.2 to 38.4% with gypsum + boron nutrition.

Significant difference in number of seed pod^{-1} was also observed only between main plots. Number of seed pod^{-1} was 5.68 in PU-31 and 4.56 in LBG-623.It was 24.6% more in PU-31. This is due to that balanced fertilization reduced the severity and incidence of the disease by increasing the metabolic activity..

100 seed weight was more in PU-31(4.8) than in LBG-623(4.64). Gypsum, boron and gypsum + boron nutrition resulted in 100 seed weight 4.7 to 5.0, 4.8 and 4.8 to 5.2 g respectively. Among these treatments the maximum value was observed with 300 kg gypsum + boron 1 kg. ha^{-1} S_{14} which was on par with S_{15} . Minimum was observed in S_4 ,which was on par with S_5, S_6, S_7, S_8 & S_9 treatments. The increase in test weight with gypsum application was 30.6 to 38.9 %, with boron application it was 33.3 % and with gypsum + boron it was 33.3 to 44.4 %.

Seed yield (kg ha $^{-1}$) obtained was more in PU-31 (1339.19) than in LBG-623 (561.66 kg.ha^{-1}). Application of gypsum, boron and gypsum + boron to LBG-623 resulted in seed yield ranging from was 741.0 to 1056.5, 830.3 to 848.1 and 877.9 to 1336.2 kg seed yield ha^{-1} respectively. Among these treatments, maximum was observed with 300kg gypsum + 1 kg Boron ha^{-1} (S_{14}) which showed significant variation with other treatments. In Pu-31, gypsum, boron and gypsum + boron application at varied levels (excepts V_1S_4) increased the seed yield (1193.4 to 1443.4, 1193.4 to 1205.3 and 1241.0 to 1836.2 kg.ha^{-1}(respectively) compared to control (995.3 kg.ha^{-1}). The maximum was obtained in V_1S_{14}, which was superior to the treatments except V_1S_{15} . Minimum seed yield was obtained in V_1S_5 and V_1S_6 which was on par with V_1S_7 . In LBG-623, application of gypsum, boron and gypsum +boron at varied levels except V_2S_2 & V_2S_4 increased the seed yield (669.6, 467.2 to 491.0 and 514.8 to 836.2 respectively) compared to control (288.6 kg ha^{-1}). Maximum seed yield was obtained in V_2S_{14} , which was on par with V_2S_{15} and minimum of it was obtained in V_2S_5 , which was on par with V_2S_6 , V_2S_7 , V_2S_8 , V_2S_9 and V_2S_{11} . Seed yield obtained in PU-31 was 2.4 folds higher than in LBG-623. The improvement in yield with gypsum application was 1.2 to 1.7 folds higher than control. Boron application improved it by 1.3to 1.4 folds and combined application of gypsum + boron improved it by 1.4 to 2.1 folds over control. Gypsum addition to PU-31improved the yield by 1.2 to 1.4 folds , boron by 1.2 fold and gypsum + boron 1.2 to 1.8 folds over control. Whereas in YMV susceptible cultivar LBG-623, gypsum addition improved the yield by 2.3 folds, boron by 1.6 to 1.7 folds and gypsum + boron by 1.8 to 2.9 folds over control. It has been reported that application of gypsum in the form of gypsum, borax and zinc sulphate reduced the YMV disease incidence in mungbean to 21 to 26 % and favored the crop to produce better with minimum reduction in pod length, 100 seed weight and seed yield compared to control. Reduction in MYMV incidence and increase in yield in mungbean with boron has been reported by Jalauddin *et al*. (2006). Similar to this reduction in disease incidence and increase in yield components and yield with gypsum nutrition has been reported in other disease by against bacterial wilt Amarendra *et al*. (2015) in mustard infected with *Alternaria* blight, with boron by Pramanik and Ali (2001) in winter mungbean against YMV and with gypsum and boron by Ali *et al*. (2014) in faba bean against chocolate spot disease.

CONCLUSION

The combined application of gypsum and boron (300 kg gypsum + boron 1 kg. ha^{-1} S_{14}) reduced the disease severity by increased the system induced resistant against the whitefly by increasing physiological defence (like phenols, peroxidase and PAL), which in tune in enhanced the level of lectin content,1,3-â glucanase enzyme activity in leaves of YMV infected blackgram and caused for increased in yield with compared to control.

Table 1. Effect of gypsum and boron nutrition on disease incidence (%) and whitefly population at 45 and 60 DAS

Treatments	Disease incidence						Whitefly count					
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
S_1: Control	9.29	100.00	54.64	13.18	100	56.59	2.75	4.60	3.67	1.48	3.01	2.25
S_2 : Gypsum@ 100 Kg.ha^{-1}	8.85	96.85	52.85	12.86	100	56.43	2.45	4.03	3.24	1.21	2.41	1.81
S_3 : Gypsum@ 200 Kg.ha^{-1}	8.22	86.73	47.47	11.71	100	55.85	1.06	2.57	1.81	0.81	1.21	1.01
S_4 : Gypsum@ 300 Kg.ha^{-1}	8.80	94.16	51.48	12.19	100	56.09	2.36	3.97	3.17	1.08	1.81	1.45
S_5 : Boron @ 1 Kg.ha^{-1}	8.79	94.13	51.46	12.39	100	56.19	2.26	3.76	3.01	1.01	1.75	1.38
S_6 : Boron @ 2 Kg.ha^{-1}	8.73	93.48	51.10	12.52	100	56.26	2.08	3.49	2.79	1.01	1.48	1.25
S_7 : Boron @ 3 Kg.ha^{-1}	8.67	93.19	50.93	12.20	100	56.10	1.98	3.31	2.64	1.01	1.61	1.31
S_8: Gypsum @100 Kg.ha^{-1}+ Boron@1Kg.ha^{-1}	8.63	93.10	50.86	12.02	100	56.01	1.93	3.24	2.58	1.01	1.55	1.28
S_9 : Gypsum @100 Kg.ha^{-1}+ Boron@2 Kg.ha^{-1}	8.57	92.30	50.43	12.10	100	56.05	1.77	3.06	2.41	0.88	1.35	1.11
S_{10}: Gypsum @100 Kg.ha^{-1}+ Boron@3 Kg.ha^{-1}	8.37	89.48	48.92	11.83	100	55.91	1.44	2.79	2.11	0.68	0.88	0.78
S_{11}: Gypsum @200 Kg.ha^{-1}+ Boron@1 Kg.ha^{-1}	8.56	92.57	50.56	12.19	100	55.09	1.70	2.96	2.33	0.95	1.21	1.08
S_{12}: Gypsum @200 Kg.ha^{-1}+ Boron@2 Kg.ha^{-1}	8.51	92.54	50.52	12.03	100	55.01	1.45	2.85	1.60	1.01	1.08	1.05
S_{13}: Gypsum @200 Kg.ha^{-1}+ Boron@3 Kg.ha^{-1}	8.48	92.46	50.47	11.85	100	55.92	1.30	2.70	2.00	0.81	1.01	0.91
S_{14}: Gypsum @300 Kg.ha^{-1}+ Boron@1 Kg.ha^{-1}	7.23	78.59	42.91	10.20	100	55.10	0.56	2.50	1.53	0.28	0.35	0.31
S_{15}: Gypsum @300 Kg.ha^{-1}+ Boron@2 Kg.ha^{-1}	7.48	82.47	44.97	10.77	100	55.38	0.69	2.50	1.60	0.41	0.88	0.65
S_{16}: Gypsum @300 Kg.ha^{-1}+ Boron@3 Kg.ha^{-1}	8.15	86.53	47.34	11.57	100	55.78	0.99	2.41	1.70	0.48	1.01	0.75
Mean	8.46	91.16		11.98	100		1.67	3.17		0.89	1.41	
	SEm	CD	CV%	SEm	CD	CV%	SEm	CD	CV%	SEm	CD	CV%
Main	0.90	5.46	12.48	1.04	6.34	12.90	0.05	0.27	12.90	0.02	0.11	10.60
Subplots	1.72	4.88	8.48	2.08	N.S	9.12	0.11	0.31	11.24	0.03	0.08	6.19
Interaction	2.44	6.90		2.94	N.S		0.16	0.44		0.04	0.12	

Table. 2. Effect of gypsum and boron nutrition on yield components and yield of YMV infected blackgram.

Treatments	No. of pods plant^{-1}			No.of seeds Pod^{-1}			Test weight			Seed Yield (Kg ha^{-1})		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
S_1: Control	13.33	9.93	11.63	5.47	4.38	4.92	3.80	3.42	3.6	995.26	288.60	621.93
S_2 : Gypsum@ 100 Kg.ha^{-1}	13.66	10.06	11.86	5.57	4.61	5.09	4.84	4.69	4.8	1193.36	360.3	776.69
S_3 : Gypsum@ 200 Kg.ha^{-1}	17.80	12.93	15.36	5.78	4.77	5.28	5.25	4.73	5.0	1443.36	669.55	1056.45
S_4 : Gypsum@ 300 Kg.ha^{-1}	13.73	10.33	12.03	5.58	4.44	5.01	4.85	4.62	4.7	1098.12	383.83	740.98
S_5 : Boron @ 1 Kg.ha^{-1}	14.26	10.66	12.43	5.58	4.49	5.03	4.87	4.64	4.8	1193.36	467.17	830.26
S_6 : Boron @ 2 Kg.ha^{-1}	14.53	11.06	12.80	5.63	4.49	5.06	4.91	4.65	4.8	1193.36	490.98	842.17
S_7 : Boron @ 3 Kg.ha^{-1}	14.80	11.53	13.16	5.63	4.49	5.06	4.94	4.67	4.8	1205.26	490.98	848.12
S_8: Gypsum @100 Kg.ha^{-1}+ Boron@1Kg.ha^{-1}	14.80	11.86	13.33	5.67	4.26	4.97	4.94	4.67	4.8	1240.98	514.79	877.88
S_9 : Gypsum @100 Kg.ha^{-1}+ Boron@2 Kg.ha^{-1}	15.13	12.06	13.60	5.67	4.50	5.09	4.98	4.67	4.8	1288.60	574.31	931.45
S_{10}: Gypsum @100 Kg.ha^{-1}+ Boron@3 Kg.ha^{-1}	16.93	12.73	14.83	5.74	4.76	5.25	5.16	4.71	4.9	1383.83	669.55	1026.69
S_{11}: Gypsum @200 Kg.ha^{-1}+ Boron@1 Kg.ha^{-1}	15.40	12.13	13.76	5.68	4.54	5.11	5.05	4.66	4.9	1312.41	574.31	943.36
S_{12}: Gypsum @200 Kg.ha^{-1}+ Boron@2 Kg.ha^{-1}	16.13	12.26	14.20	5.68	4.54	5.11	5.06	4.68	4.9	1348.12	621.93	985.03
S_{13}: Gypsum @200 Kg.ha^{-1}+ Boron@3 Kg.ha^{-1}	16.53	12.46	14.50	5.68	4.54	5.11	5.14	4.68	4.9	1348.12	633.83	990.98
S_{14}: Gypsum @300 Kg.ha^{-1}+ Boron@1 Kg.ha^{-1}	21.13	13.73	17.43	5.89	4.83	5.36	5.41	4.97	5.2	1836.22	836.22	1336.22
S_{15}: Gypsum @300 Kg.ha^{-1}+ Boron@2 Kg.ha^{-1}	21.06	13.60	17.33	5.79	4.65	5.22	5.27	4.95	5.1	1752.88	729.07	1240.98
S_{16}: Gypsum @300 Kg.ha^{-1}+ Boron@3 Kg.ha^{-1}	20.06	13.06	16.56	5.79	4.65	5.22	5.26	4.75	5.0	1633.83	681.45	1157.64
Mean	16.20	11.90		5.68	4.56		4.98	4.64		1339.19	561.66	
	SEm	CD	CV%	SEm	CD	CV%	SEm	CD	CV%	SEm	CD	CV%
Main	0.14	0.86	6.99	0.07	0.42	9.27	0.02	0.10	2.35	17.43	106.03	12.70
Subplots	0.24	0.68	4.22	0.24	NS	11.71	0.07	0.18	3.32	33.25	94.07	8.57
Interaction	0.34	0.97		0.35	NS		0.09	NS		47.03	133.03	

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(Received on 11.07.2016 and revised on 30.06.2017)