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Growth, Yield attributes and Yield of *Bt* Cotton as Influenced by Phosphorus levels, PSB and FYM

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ABSTRACT

A field experiment was conducted to study the response of *Bt* cotton to phosphorus levels, phosphorus solubilising bacteria (PSB) and farmyard manure (FYM) on a clay loam soil at Agricultural College Farm, Bapatla during *kharif*, 2011. Highest biomass, boll number and yield were recorded by the integrated treatment that received RDP+PSB+FYM followed by RDP+FYM and RDP+PSB with an increase of 32, 25 and 8 per cent in seed cotton yield, respectively over only inorganic treatment. The treatment that received 50% RDP+PSB+FYM was at par with application of RDP in seed cotton production.

Key words : Biomass, seed cotton yield and integrated nutrient management.

Phosphorus is one of the major nutrients and it plays an important role in plant metabolism by supplying energy required for metabolic processes (Lal, 2002). There is a constant increase in prices of inputs like fertilizers raising the production cost and narrowing down profit margins. Phosphorus fertilizer is an expensive input with low use efficiency by crops (10-25 %) (Bahl and Singh, 1986) due to the conversion of major part of the fertilizer phosphorus into insoluble and unavailable forms through chemical fixation in soils. One viable alternative for increasing the use efficiency of applied nutrients is opting for integrated nutrient supply system (INSS) which prilmarily relates to the combined use of chemical fertilizers, organic manures and biofertilizers. Hence use of micro-organisms coupled with organics (i.e. farmyard manure) is an option to augment the availability of P in easily assimiliable form by the crops (Poonamgautam *et al.*, 2003). The knowledge related to influence of use of different sources of nutrients in *Bt* cotton is lacking. Hence, the present investigation was conducted to study the response of *Bt* cotton to inorganic P, PSB and FYM and their combination.

MATERIAL AND METHODS

A field experiment was conducted on a clay loam soil at Agricultural College Farm, Bapatla, Guntur district, Andhra pradesh, India during *kharif,* 2011. The experimental soil was alkaline in reaction (7.8) , medium in organic carbon (0.52 %), low in available nitrogen (203 kg ha^{-1}), medium in available phosphorus (32 kg ha^{-1}) and high in available potassium (750 kg ha^{-1}). The experiment was laid out in randomized block design with 10 treatments replicated thrice. Treatment details were as follows: T_1 = RDP (60 kg P_2O_5 ha^{-1}); T_2 = RDP+PSB; T_3 = 50% RDP+PSB; T_4 = PSB; T_5 = RDP+FYM; T_6 = 50% RDP+FYM; T_7 = FYM; T_8 = RDP+PSB+FYM; T_9 = 50% RDP+FYM and T_{10} = PSB+FYM. Farmyard Manure @ 10 t ha^{-1} was applied 10 days prior to sowing while phosphorus solubilising bacteria @ 5 kg ha^{-1} was applied one day before sowing. Phosphorus was applied as per the treatments basally at sowing whereas, the recommended dose of nitrogen and potassium (120 and 60 kg ha^{-1}, respectively) were applied in four equal splits at 20, 40, 60 and 80 DAS. A total rainfall of 627.8 mm was recorded during the crop growth period. Biomass at 45, 90 and harvest was

calculated expressed as kg ha^{-1}. The cumulative number of bolls at maturity from five tagged plants was used for computing number of bolls per plant. The kapas from ten fully opened bolls was collected in each picking, then the average of four pickings was taken as the mean boll weight and expressed in grams. Cotton yield obtained from four pickings of net plots was used to calculate the seed cotton yield in q ha^{-1}. Fisher's method of analysis of variance was followed for analysis and interpretation of the data as suggested by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Plant height

Data on plant height (Table 1) revealed no significant influence of treatments at 45 DAS, but at 90 DAS and harvest, application of FYM with or without integration (T_5-T_{10}) resulted in significant effect. The maximum height of 121 cm was observed in the treatment that received integrated application of RDP+PSB+FYM. Phosphorus levels didn't show any significant difference in plant height. The increase in plant height in FYM treated plots might be due to direct addition of nutrients to the soil pool and improved soil conditions that favoured the plant growth. Significant increase in plant height with FYM application was recorded by Ramprakash and Mangalprasad, (2000).

Biomass production

The results (Table 1) indicated progressive increase in biomass yield with advancement of crop growth in all the treatments. However, the magnitude of such changes varied with treatments, being the highest (8349 kg ha^{-1}) recorded in treatment T_8 at harvest, which might be due to combined application of PSB+FYM along with RDP that caused maximum availability of nutrients as compared to their respective sole application. Further a significant increase in biomass was observed with increase in phosphorus levels. The lowest biomass production (432, 3080 and 4814 kg ha^{-1}during 45, 90 DAS and harvest, respectively) was recorded in the treatment that received PSB @ 5 kg ha^{-1} (T_4). The decrease in biomass at lower levels of phosphorus even though supplemented with PSB or FYM or their combination indicate the role of readily available phosphorus in plant metabolism. Inadequate supply of phosphorus can impair stomatal conduction and photosynthetic CO_2 fixation which inturn reflect on shoot growth and subsequent lesser biomass accumulation (Vieira, *et al.*, 1998). Similar results were observed by Iqbal *et al.* (2001) and Yadav *et al.* (2005), respectively.

Number of bolls per plant

The data pertaining to number of bolls per plant (Table 2) revealed that the highest number of bolls for plant (55) was observed in T_8 (RDP + PSB + FYM) followed by T_5 (RDP + FYM), which were statistically on a par and markedly superior over other treatments. This can be ascribed to improved soil conditions and continuous supply of nutrients in adequate quantities due to mineralisation and enhanced solubilisation of P from insoluble sources. Addition of PSB along with recommended dose of phosphorus (T_2) recorded significant increase in boll number over treatment received only inorganic phosphorus which could be due to production of growth promoting substances and vitamins by biofertilizers that helps in higher retention of flower buds (Sardana, 1997). The treatment T_9 (50% RDP ha^{-1} + PSB + FYM) was on a par with T_1 (RDP) indicating the role of PSB and FYM in supplementing the necessary nutrient elements. The lowest number of bolls (28) was recorded by T_4 (PSB @ 5 kg ha^{-1}), which might be the result of unfavourable physiological changes in plant brought about by shortage of phosphorus, that is essential for cell division, meristematic growth and differentiation into floral buds and bolls. Iqbal *et al.* (2001) reported a decrease in fruit shedding with each increment of phosphatic fertilizer dose. The results were coinciding with the findings of Katkar *et al.* (2002).

Boll weight

The data (Table 2) indicated no significant effect of FYM and PSB either alone or in combination with phosphorus levels on boll weight. However, the highest boll weight (5.90 g) was recorded by the treatment T_8 (RDP + PSB + FYM) and the lowest (5.39 g) was recorded by T_{10}. Similar non-significant effect of FYM on boll weight in cotton was reported by Zou, (1985) and Eshanov and Eshanov, (1991).

Seed cotton yield and stalk yield

Table 1. Influence of phosphorus levels, PSB and FYM on plant height and biomass production.

Treatments	Plant height (cm)			Biomass production (kg ha^{-1})		
	45 DAS	90 DAS	Harvest	45 DAS	90 DAS	Harvest
T_1-RDP	29	76	106	540	3858	5743
T_2-RDP+PSB	29	78	107	574	3951	6486
T_3-50%RDP+PSB	26	74	106	481	3463	5047
T_4-PSB	27	76	106	432	3080	4814
T_5-RDP+FYM	29	87	117	611	4451	7339
T_6-50%RDP+FYM	29	89	114	537	3870	5277
T_7-FYM	27	84	116	469	3475	4943
T_8-RDP+PSB+FYM	26	90	121	660	4698	8349
T_9-50%RDP+PSB+FYM	27	91	117	562	4160	5436
T_{10}-PSB+FYM	28	87	117	500	3654	5029
SEm±	2	3	2	27	89	160
CD@0.05	NS	6	5	81	263	475
CV(%)	10	6	3	9	4	5

Table 2. Influence of phosphorus levels, PSB and FYM on number of bolls per plant, seed cotton and stalk yied

Treatments	Number of bolls per plant	Boll weight (g)	Seed cotton yield (q ha^{-1})	Stalk yield (q ha^{-1})
T_1-RDP	46	5.48	23.17	34.25
T_2-RDP+PSB	49	5.72	25.05	39.81
T_3-50%RDP+PSB	37	5.57	18.04	23.46
T_4-PSB	28	5.60	14.99	16.05
T_5-RDP+FYM	52	5.86	28.95	44.44
T_6-50%RDP+FYM	39	5.35	20.55	30.25
T_7-FYM	33	5.63	16.66	22.84
T_8-RDP+PSB+FYM	55	5.90	30.63	52.47
T_9-50%RDP+PSB+FYM	42	5.51	22.26	32.10
T_{10}-PSB+FYM	35	5.39	17.57	23.15
SEm±	1	0.16	0.50	2.60
CD@0.05	3	NS	1.44	7.64
CV(%)	6	5.03	4.03	13.96

The perusal of the data presented in table 2 revealed that significantly highest seed cotton yield (30.63 q ha^{-1}) was recorded by the treatment T_8 that received combined application of RDP + PSB + FYM over all other treatments. The treatment T_5 (RDP + FYM-28.95 q ha^{-1}) was significantly superior over T_2 (RDP + PSB-25.05 q ha^{-1}), which recorded a marked increase in seed cotton yield over the remaining treatments. The treatment T_9 which received 50% RDP ha^{-1} + PSB + FYM (22.26 q ha^{-1}) was found to be on a par with T_1 (RDP-23.17 q ha^{-1}) and significantly superior over the remaining treatments that received PSB and FYM alone or in combination with 50% RDP ha^{-1}.

Stalk yield followed the same pattern as seed cotton yield. The highest stalk yield (52.47 q ha^{-1}) was recorded in the treatment (T_8) with combined application of RDP + PSB + FYM, which was significantly superior over all other treatments and followed by the treatment (T_5) that received RDP + FYM (44.44 q ha^{-1}). The next best treatment T_2 which received RDP along with PSB was on a par with T_1 (RDP) and significantly superior over other treatments. The Treatments receiving 50% RDP + PSB + FYM (T_9) and 50% RDP + FYM (T_6) recorded slightly lower stalk yields but were on a par with T_1 (RDP).

Critical observation of data revealed that application of PSB and FYM along with RDP resulted in highest yield. The increase in yield at higher level of phosphorus (RDP) might be due to its effect through proliferation of root system which increased the uptake of nutrients resulting in increased plant growth, number of bolls and finally yield. Higher seed cotton yield in organic treated plots either alone or in combination with PSB could be ascribed to regular supply of all the nutrients in required proportions at all the stages of crop growth. Further, the increase in yield attributes might have been an account of the overall improvement in the vegetative growth of the plant due to the integrated use of FYM, chemical fertilizers and biofertilizers which ought to have favoured translocation of photosynthates to sink and flowers (Halevy, 1979). Plant growth regulating substances like indole acetic acid, gibberellic acid and cytokinins produced by PSB also might have helped in boosting the yields of seed cotton and stalk (Kharche *et al.,* 1990). The results are in conformity with the findings of and Saleem *et al.* (2010).

It can be concluded that the increase in phosphorus nutrition significantly influenced the biomass production, boll number and seed cotton yield, whereas plant height was influenced by the organic treatment but either phosphorus dose or organic treatment could not affect the boll weight. The combined application of PSB+FYM found superior than individual application of either PSB or FYM at an applied level of phosphorus. Addition of 50% RDP+PSB+FYM was found to be on a par with addition of only RDP. Hence the fertilizer P dose can be reduced to half by integrating with PSB and FYM.

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