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Synchronizing nitrogen and potassium supply with crop demand to augment growth, productivity and economics of Bt. Cotton hybrid (NSPL-999)

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Abstract
A field experiment was conducted to assess N and NK split application synchronize with crop demand. Eight timings of application and two different dose of N and NK both were taken as different treatments. Timings were planned to supply the fertilizer at different crop growth stages i e., at 10, 30, 45, 60 and 75 DAS. Split application of N and NK did not have any significant effect on plant height, monopodia per plant, sympodia per plant, boll per plant, boll weight, and Ginning Percentage. Bolls per plant was significantly increased with $N_{120}K_{40}$ Rs/ha. Split application as well as, 03 split application (10, 30 & 60 DAS). The seed cotton yield did not deviate significantly due to split-cum-basal fertilizer application; however timings of 03 split application of fertilizers(10, 30 & 60 DAS) resulted in significant changes in this productivity parameter. Significantly more, net income from $N_{120}K_{40}$ was only Rs. 2884/ha. Over N_{120} split application. Amongst the timing of split application, three splits application either 10, 30 and 60 or 10, 45 & 60 DAS proved significantly superior than remaining treatments, Seed cotton yield ranged from 21.15 to 21.19 q/ha with extra net income from Rs. 6109 to Rs. 6205 / ha under 03 split (either 10, 45 & 60 or 10, 30 & 60 DAS) over 2 split application (10 & 45 DAS).

Keywords: Bt cotton, nitrogen, potassium, split application, economics

Introduction
Cotton is an important commercial crop in India because it plays vital role in Indian economy. Bt cotton has been developed by transferring crystal protein gene (Cry1AC) from a soil bacterium Bacillus thurigiensis var. Kurstaki in to cotton. Research on Bt cotton in India is monitored and resulted by the department of Biotechnology, In northern cotton growing states, Viz. Punjab, Haryana and Rajasthan, six Bt cotton hybrids were approved for commercial cultivation for the first time during 2005. Out of these six Bt cotton hybrids, two each have been developed by Mahyco (MRC 6301 Bt and MRC 6304 Bt), Rasi seeds (RCH 134 Bt and RCH 317 Bt) and Ankur seeds (Ankur 651 Bt and Ankur 2534 Bt) (Singh and Kaushik, 2007) [8]. Split application of both nitrogen and potassium is recommended in Andhra Pradesh, Kerala, Orisa and Uttar Pradesh. Nitrogen is most essential nutrient for plant growth needs to be supplied in proper time and quantities. A positive correlation between vegetative growth and the number of fruiting points produced by cotton is well known. N supplement therefore by split application becomes important as it is supplied ideally in a time when crop critically requires. Bt cotton differs in its requirement either by total of it in the different stages of crop.
Split applications of nitrogen fertilizer can play an important role in a nutrient management strategy that is productive, profitable and environmentally responsible. Application of nitrogen in two or more than two splits doses can help growers enhance nutrient efficiency, promote optimum yield and mitigate the loss of nutrient. Potassium (K) is the third major essential plant nutrient along with N and P. Potassium plays a specific role in most plant species in opening and closing of stomata which cannot be done by other cation (Saxena, 1985) [6]. It increases root growth and improves drought resistance, activates many enzymes systems, reduce water loss and willing, prevent energy losses and aids in photosynthesis, respiration and food formation (Tiwari, 2001) [11]. As the requirement of plants to potassium differ from stage to stage (Brady, 1996) [2] and there might be better response of plants to potassium, if potassium is applied in splits at different stages. Present study was initiated using Bt cotton as test crop to find out the appropriate mode and split application of N and NK for enhancing productivity.

Materials and methods
The experiments were conducted at the JNKVV (Now RVSKVV), Regional Agricultural Research Station, Khandwa (M.P) during 2010-11 and 2011-12 in medium black clay-loam soil.

The soil was slightly alkaline (pH.) with low in organic carbon (0.30-0.20 %), available N (191-198 kg/ha), medium in P_2O_5 (13.0-19.2 kg/ha.) and K_2O. (282-288 kg/ha.) The treatments comprises two Mode of fertilizers application in main-plots (F1-N120 as split & P60, K40 as basal and F2-N120, K40 as split & P60 as basal and 08 Timing of split application in sub plots (S1-2 Splits (10 & 45 DAS), S2- 3 Splits (10, 45 & 75 DAS), S3- 3 Splits (10, 30 & 45 DAS), S4- 3 Splits (10, 30 & 60 DAS), S5- 3 Splits (10, 45 & 60 DAS), S6-3 Splits (10, 30 & 75 DAS), S7-4 Splits (10, 30 45 & 60 DAS) and S8-4 Splits (10, 30, 45 & 75 DAS). The treatments were laid out in split – plot design with three replications. The hybrid cotton Bt NSPL-999 was sown on 26.05.2010 and 28.05.2011 and keeping 90 x 90 cm planting geometry. The fertilizers were applied @ 120 kg N, 60 kg P_2O_5 and 40 Kg K_2O / ha through Urea, SSP and MOP, respectively as per the treatments. In NK split dose plots, only P was applied as recommended dose as basal, while N and K was applied at the same rates in splits as per treatments. The crop was grown as per recommended package of practices. The crop was harvested in three pickings ending by 25 and 28 February in 2011 and 2012, respectively. The periodical observations were recorded with respect to growth and productivity. The net income was estimated as per existing market rates of the inputs and the produce per hectare.

Results and discussion

Growth parameter

Morphological growth observations recorded periodically [Table-1] has exhibited many interesting architectural variations due to applied mode and timings of NPK applications. As regards with the mode of fertilizer application i.e. N_{120} split with P and K basal (F_1) or N_{120} K_{40} split with P basal (F_2), the plant height, number of monopodia and sympodia per plant did not influence upto significant extent but conspicuous higher value of plant height and monopodia were recorded under N_{120} split with P and K basal while sympodia were was found marginal higher in N_{120} K_{40} and P basal.

The identical influence of F_1 and F_2 mode of NPK fertilizer application upon these growth parameters may be owing to the fact that the NPK fertilizer dose applied to the crop plants was the same in F_1 and F_2 i.e. $N_{120}P_{60}K_{40}$. The difference was only in their mode of application (split or basal) where these major nutrients supplied to the hybrid cotton plants was the same. Similarly, a non-significant effect due to split application of N was recorded by Solaiappan and Sheriff (1994) [9] and Hallikeri *et al*. (2010) [3].

The different number and timings of split application of fertilizers also did not exert significant impact upon the growth parameters of Bt cotton hybrid. This might be due to the fact that the total amount of N_{120} as split $_{and}$ basal P_{60} K_{40} (F_1) or $N_{120}K_{40}$ split with P_{60} basal (F_2) fertilizers applied was the same, only timings in their split applications were varied as per treatments. Such variation in the timing of their split applications did not bring about any favourable or unfavourable effect upto higher extent upon these growth parameters. Moreover, the pool of soil reserve of nutrients plus already split-applied nutrients supplemented the nutritional requirement of the actively growing plants under the situation of wide gap in the fertilizer splitting. The non-significant variation in the values of all the eight treatments (S_1 to S_8) did not show any definite or conclusive trend against these growth parameters. It is difficult to compare the efficacy of the treatments for a certain growth parameter. Similarly, a non-significant effect due to split application of N was recorded by Solaiappan and Sheriff (1994) [9] and Hallikeri *et al*. (2010) [3].

Yield and yield-attributes

The formation of bolls per plant was found significantly higher N_{120} K_{40} split + P_{60} basal due to mode of NPK fertilizer application. This might be due to continued availability of nitrogen and potassium to the crop all through its growth period. This result is agreement with the findings of Mondal *et al*. (1982) [5]. While, the boll weight and seed cotton yield was not deviated up to significant extent. Such effect might be due to almost same amount of N, P, K application. Similarly, a non-significant effect due to split application of N was recorded by Solaiappan and Sheriff (1994) [9] and Hallikeri *et al.* (2010) [3]. However, F_2 ($N_{120}K_{40}$ split + P_{60} basal) proved slightly better than F_1 (N_{120} split + $P_{60}K_{40}$ basal) in seed cotton yield. The increase in F_2 was upto 1.43 bolls /plant and 0.8 q/ha seed cotton yield than and F_1. The non-significant increase in yield and yield-attributes might be attributed to non-significant increase in growth parameters under both these modes of fertilizer application (F_1 and F_2). The rate of NPK application was the same in F_1 and F_2 treatments hence, the non-significant impact of such treatments was eventually observed.

The number and timings of split application of nitrogen and potash fertilizers brought about significant changes in the formation of bolls per plant as well as seed cotton yield of Bt cotton hybrid NSPL-999. Supplementation of N at these stages may be ideal to meet the requirement even for Bt-cotton (Srinivasan 2003) [10]. The treatment S_4 having three splits at 10, 30 and 60 DAS resulted in maximum bolls (14.22/plant) as well as seed cotton yield upto 21.20 q/ha. This was closely followed by S_5 and S_7 (13.37 to 13.93 bolls/plant and 20.16 to 21.15 q/ha seed cotton yield). The higher yield and yield-attributes in these treatments might be owing to slightly increased plant growth parameters over the other treatments. This facilitated the increased photosynthesis thereby increased translocation of food materials from vegetative parts towards the sink. Ultimately the whole process accelerated the formation and development of greater sink size and weight thus increasing the seed cotton yield. Similar results were also reported by Khan and Dar (2006) [4], Bhatia and Singh (2015) [1]. The overall results indicate that the N and K fertilizers may be splitted thrice at 10, 30 or 45 and 60 days after sowing to achieve the best response. Secondly it was also apparent from the results that two times splits or four times splits of N and K fertilizers were not found so advantageous. At any other timing, split application of N and NK both exhibit non-significant differences. These results cannot be supported from those of other researchers because of the fact that such type of studies in Bt cotton hybrids have not been conducted so far based on the available literature in India or abroad.

Ginning percentage

The mode of fertilizer application as well as timings of split fertilizer application did not deviate the ginning percentage of Bt. cotton hybrid. Similarly, a non-significant effect on ginning percentage due to split application of N was recorded by Solaiappan and Sheriff (1994) [9] and Hallikeri *et al*. (2010) [3]. In case of mode of fertilizer application (F_1 and F_2), the ginning percentage ranged from 33.37 to 33.98 %. Similarly, amongst the timings of split fertilizer application, S_1 recorded lowest 32.75 % to S_3 gave the maximum 34.34 % ginning

Table 1: Growth, yield attributes of *Bt.* cotton hybrid NSPL-999 as influenced by N and K supply at different timings of split application (2010-11 and 2011-12)

Treatments		Plant height (cm)			Monopodia / plant			Sympodia / plant			Bolls / plant)			Weight of boll (g)		
(A) Mode of fertilizer application		2010-11	2011-12	Mean	2010-11	2011-12	Mean	2010-11	2011-12	Mean	2010-11	2011-12	Mean	2010-11	2011-12	Mean
F_1	N_{120} (P_{60} K_{40} basal)	77.57	79.36	78.45	0.56	0.99	0.77	11.40	11.86	11.61	11.10	11.57	11.34	3.51	3.97	3.72
F_2	N_{120} K_{40} (P_{60} basal)	74.45	76.21	75.33	0.54	0.96	0.75	11.50	11.92	11.71	12.56	12.98	12.77	3.40	3.82	3.61
CD (P = 0.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS	0.86	0.82	0.84	NS	NS	NS
(B)Timings of split applications																
S_1	2 Splits (10 & 45 DAS)	75.87	77.79	76.75	0.52	0.98	0.73	12.06	12.65	12.27	12.15	12.73	12.44	3.43	4.01	3.64
S_2	3 Splits (10, 45 & 75 DAS)	74.95	76.71	75.83	0.50	0.92	0.71	10.99	11.41	11.20	10.57	10.99	10.78	3.45	3.87	3.66
S_3	3 Splits (10, 30 & 45 DAS)	70.92	72.68	71.80	0.47	0.89	0.68	11.36	11.78	11.57	10.90	11.32	11.11	3.16	3.58	3.37
S_4	3 Splits (10, 30 & 60 DAS)	78.39	80.15	79.27	0.59	1.01	0.80	11.69	12.11	11.90	14.01	14.43	14.22	3.60	4.02	3.81
S_5	3 Splits (10, 45 & 60 DAS)	79.21	80.96	80.08	0.59	1.01	0.80	11.14	11.56	11.35	13.16	13.58	13.37	3.68	4.10	3.89
S_6	3 Splits (10, 30 & 75 DAS)	72.06	73.81	72.94	0.54	0.96	0.75	11.72	12.14	11.93	9.89	10.31	10.10	3.54	3.96	3.75
S_7	4 Splits (10, 30 45 & 60 DAS)	79.53	81.28	80.41	0.62	1.04	0.83	11.49	11.91	11.70	13.72	14.14	13.93	3.62	4.04	3.83
S_8	4 Splits (10, 30, 45 & 75 DAS)	77.15	78.91	78.03	0.54	0.96	0.75	11.16	11.58	11.37	10.26	10.68	10.47	3.18	3.60	3.39
CD (P = 0.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS	3.12	3.19	3.11	NS	NS	NS

Table 2: Seed cotton yield, ginning percentage and Economics of *Bt.* cotton hybrid NSPL-999 as influenced by N and K supply at different timings of split application (2010-11 and 2011-12)

Treatments		Seed Cotton Yield (q/ha.)			Ginning (%)			Cost of cultivation (Rs/ha.)		Net income (Rs./ha)			Benefit: cost ratio		
(A) Mode of fertilizer application		2010-11	2011-12	Mean	2010-11	2011-12	Mean	2010-11	2011-12	2010-11	2011-12	Mean	2010-11	2011-12	Mean
F_1	N_{120} (P_{60} K_{40} basal)	18.15	18.92	18.53	33.13	33.65	33.37	15500	16500	28963	32242	30602	2.85	3.01	2.89
F_2	N_{120} K_{40} (P_{60} basal)	19.02	19.79	19.40	33.77	34.19	33.98	15500	16500	31099	34455	32777	3.00	3.15	3.08
CD (P = 0.05)		NS	NS	NS	NS	NS	NS	NS	NS	211	103	103	0.16	0.12	0.14
(B) Timings of split applications															
S_1	2 Splits (10 & 45 DAS)	18.50	19.28	18.89	32.43	33.24	32.84	15500	16500	29812	33158	31485	2.92	3.05	2.99
S_2	3 Splits (10, 45 & 75 DAS)	16.97	17.73	17.35	34.12	34.54	34.33	15500	16500	26072	29223	27648	2.65	2.85	2.75
S_3	3 Splits (10, 30 & 45 DAS)	17.74	18.50	18.12	33.13	33.55	33.34	15500	16500	27955	31182	29669	2.80	2.95	2.88
S_4	3 Splits (10, 30 & 60 DAS)	20.81	21.58	21.20	33.82	34.24	34.03	15500	16500	35485	39020	37253	3.30	3.40	3.35
S_5	3 Splits (10, 45 & 60 DAS)	20.77	21.54	21.16	33.29	33.71	33.50	15500	16500	35390	38921	37156	3.30	3.40	3.35
S_6	3 Splits (10, 30 & 75 DAS)	16.70	17.46	17.08	34.04	34.46	34.25	15500	16500	25403	28526	26965	2.60	2.80	2.70
S_7	4 Splits (10, 30, 45 & 60 DAS)	19.77	20.53	20.15	33.82	34.24	34.03	15500	16500	32933	36364	34649	3.10	3.30	3.20
S_8	4 Splits (10, 30,45 & 75 DAS)	17.43	18.19	17.81	32.96	33.38	33.17	15500	16500	27199	30395	28797	2.75	2.90	2.83
CD (P = 0.05)		3.90	3.91	3.89	NS	NS	NS	NS	NS	419	206	743	0.32	0.24	0.24

percentage. The non-significant differences among the different treatments may be due to the fact that all the treatments possessed equal amount to NPK fertilizers which resulted in equal impact upon this parameter. Hallikeri *et al*. (2010) [3] have also found the similar results.

Economics

The fertilizer application having $N_{120}K_{40}$ applied as split and P_{60} as basal resulted in maximum net income upto Rs.32,777/ha, whereas only one major nutrient N_{120} was applied as split and $P_{60}K_{40}$ as basal gave less income (Rs.30,602/ha) i.e. loss by Rs.2,175/ha. This may be due to the fact that split application of two major nutrients proved more advantageous than only one major nutrient i.e. nitrogen. That means, K proved more advantageous when applied as split application than it was applied as the basal. In fact in split application of fertilizers, the nutrients are available to the growing at different intervals whereas in case of basal application, the availability of nutrients may be so fast to meet out the immediate requirement by the plants. This results in increased yield and thereby net income.

Timings of split applications, S_4 and S_5 treatments having 3 timings of split resulted in equally higher net income from Rs.37,253 to Rs.37,156/ha being extra by Rs.6,651 to Rs.6,554/ha over S_1 having only 2 timings of splits. This might be owing to the availability of same dose of nutrients during three periods at the proper (appropriate) timings upto 60 DAS rather than same dose in two splits upto 45 DAS only. Thus, the different timings of fertilizer application is most important to the actively growing plants. It is also apparent from the results that splitting late upto 75 DAS as in S_2, S_6, S_8 was not found advantageous. Full applied dose must be finished upto 60 DAS growth period because later on the fertilizer requirement may not be required more by the plants. Accordingly it reflected upon the yield and consequently upon the net income. Benefit: cost ratio is another expression of net gain; hence it was automatically come out according to that of the net income from the various treatments.

References

1. Bhatia AS, Singh M. Effect of split application of nitrogen and potassium on yield, nutrient uptake and nutrient use efficiency in Bt cotton. Annals of Plant and Soil Research. 2015; 17(1):71-73.
2. Brady NC. The Nature and properties of soils.Prentice hall of India Pvt. Ltd., New Delhi. 1996, 369.
3. Hallikeri SS, Halemani HL, Patil VC, Palled YB, Patil BC, Katageri IS. Effect of nitrogen levels, split application of nitrogen and detopping on seed cotton yield and fiber quality in Bt cotton. Karnataka Journal of Agricultural Sciences. 2010; 23(3):418-422.
4. Khan MB, Dar JS. Response of cotton (*Gossypium hirsutum*) cultivars to different levels of nitrogen. Journals of Research (Science). 2006; 17(4):257-261.
5. Mandal SS, Dasmahapatra AN, Chatterjee BN. Potassium nutrition at high level of N fertilization on rice. Potash Review. 1982; 52:1-7.
6. Saxena NP. The role of potassium in drought tolerance. Potash Review, 1985; 55:37-38.
7. Senthivel T, Palaniappan SP. Effect of Potash top dressing through NK granules on yield and nutrient uptake of rice under low land conditions. Journal of potassium Research. 1985; 1:166-173.
8. Singh J, Kaushik SK. Bt cotton in India, India farming. 2007; 56:25-28.
9. Solaiappan U, Sherif Mohammed N. Effect of tillage practices and nitrogen application in cotton (*Gossypium* spp.) grown after rice. Indian Journal of Agronomy, 1994; 39(2):302-304.
10. Srinivasan G. Response of cotton (*Gossypium hirsutum*) to split applicaton of major nutrients. Indian Journal of Agronomy. 2003; 48:59-61.
11. Tiwari KN. Potassium needs of Indian soils and crops. Fertilizer Marketing News. 2001; 32(10):1-7.