The Pharma Innovation Journal 2022; 11(12): 357-359

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 357-359

www.thepharmajournal.com
Received: 15-09-2022
Accepted: 22-10-2022

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Effect of fertigation on growth and yield of *Bt.* cotton (*Gossypium hirsutum* L.)

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Abstract
The present experiment was undertaken to evaluate the effect of fertigation on growth and yield of *Bt.* cotton during 2019–20 at the Soil and Water Management Research Farm, Navsari. The experiment was laid out in a randomised block design with four replications and ten treatments. The results revealed that application of 100% NPK through fertigation (T_1) recorded significantly higher plant height, dry matter accumulation, number of sympodial branches/plant, number of bolls/plant, cotton weight per plant, seed cotton yield and stalk yield, but it remained at par with 100% N & K through fertigation with 100% P applied as basal (T_2), 100% N through fertigation with 100% P & K applied as basal (T_3), 80% NPK through fertigation (T_4), 80% N & K through fertigation with 80% P applied as basal (T_5) and 80% N through fertigation with 80% P & K applied as basal (T_6). Lower growth, yield attributes, and yield were recorded under 80% N fertigation with 80% P and K applied as basal (T_9). Boll weight did not remarkably vary under different levels of fertigation.

Keywords: *Bt.* cotton, drip fertigation levels, water soluble fertilizer, seed cotton yield

Introduction
Cotton is the world's leading fibre crop and known as "white gold," cotton production, processing and trade provide livelihood and employment to several millions of people. The introduction of *Bt.* cotton in 2002, the area under this crop and the number of farmers who adopted this technology expanded significantly year after year. An application of an optimum dose of fertilizer (N, P and K) is important from the production, quality and cost of production point of view. Fertigation is the most effective and convenient means of maintaining optimum fertility levels and water supply according to the specific needs of each crop and type of soil resulting in higher yields and better-quality the crop. Fertigation offers the advantages of saving on fertilizers as well as the increase in fertilizer use efficiency (Nakayama and Bucks, 1986) [4]. Fertigation is the only way to manage these resources efficiently. It is found most important for applying fertilizer at the proper time and as per crop demand. Application of water soluble fertilizers along with irrigation water near the root zone as per the need of the crop, to improve the fertilizer use efficiency. Recently, water soluble fertilizer is available in the market and the solubility of this fertilizer is higher, so less quantity requires and easily apply through a drip system to improve the efficiency of these fertilizers.

Materials and Methods
The field trial was carried out in 2019-20 at Soil and Water Management Research Farm, Navsari. The experiment was laid out in randomized block design with four replications and ten treatments. The treatment consisted of different levels of fertigation *viz*., T_1:100% NPK through fertigation, T_2:100% N & K through fertigation with 100% P applied as basal, T_3:100% N through fertigation with 100% P & K applied as basal, T_4:80% NPK through fertigation, T_5:80% N & K through fertigation with 80% P applied as basal, T_6:80% N through fertigation with 80% P & K applied as basal, T_7:60% NPK through fertigation,T_8:60% N & K through fertigation with 60% P applied as basal, T_9:60% N through fertigation with 60% P & K applied as basal and T_{10}: 100% NPK applied in soil (As per recommendation). The soils of the experimental unit were clayey in texture, alkaline in nature with normal electrical conductivity, low in organic carbon and available nitrogen, medium in available phosphorus and fairly high in available potassium. Five randomly chosen plants from a net plot were used to collect data on plant growth and yield characteristics. From the net plot, the cotton yield per ha was reported. Data were statistically analyzed by the standard procedure of Panse and Sukhatme (1967) [5].

Result and Discussion

Growth parameter

Different fertigation treatment significantly influences the plant height, dry matter accumulation and no. of sympodial branches/plant. Among the drip fertigation levels, fertigation levels at 100% NPK through fertigation (T_1) recorded significantly higher plant height, dry matter accumulation and no. of sympodial branches/plant. However, 100% N & K through fertigation with 100% P applied as basal (T_2), 100% N through fertigation with 100% P & K applied as basal (T_3), 80% NPK through fertigation (T_4), 80% N & K through fertigation with 80% P applied as basal (T_5) and 80% N through fertigation with 80% P & K applied as basal (T_6) treatments were statically at par with T_1. The plant height was higher when the fertilizers were applied through drip fertigation in split doses as compared to soil application fertilizer. It is very well theorized that nitrogen application boosts plant growth, being one of the most important nutrients with its role in plant metabolism and development. Thus, nitrogen is responsible for the vegetative growth of cotton plants. Plant height was increased with increasing the level of N application by drip fertigation reported by Veeraputhiran *et al.* (2005) [7] and Gawali *et al.* (2020) [2]. Bhalerao *et al.* (2011) [1] reported higher dry matter accumulation when fertilizers were applied through fertigation. A significantly higher number of sympodial/plant recorded with higher levels of fertigation due to higher uptake of nutrients and further vegetative growth of the *Bt*. cotton.

Yield attributes

The data indicated in Table 2, the yield characteristics like numbers of bolls per plant and seed cotton weight per plant influence significantly due to levels of fertigation. Application of 100% fertilizer dose with fertigation increase the yield attributes than lower levels of fertigation. Lover values of yield attributing characters were recorded with 60% fertigation levels. The substantial increase in the number of bolls per plant and seed cotton weight per plant due to higher levels of fertigation than lower level and conventional methods was associated with the improvement in various growth attributes *viz.* Plant height, number of sympodial branches per plant and dry matter accumulation per plant and its subsequent translocation to sink Kakade *et al.* (2017) [3]. Boll weight of *Bt.* cotton was not influence significantly due to different levels of fertigation.

Table 1: Growth parameters at harvest of *Bt.* cotton as influenced by different treatments of fertigation

Treatment			Plant height (cm) at harvest	Dry weight (g/plant) at harvest	Number of sympodial branches/plant
T_1	:	100% NPK through fertigation	152.8	276	27.0
T_2	:	100% N & K through fertigation with 100% P applied as basal	150.9	274	26.5
T_3	:	100% N through fertigation with 100% P & K applied as basal	149.7	250	26.2
T_4	:	80% NPK through fertigation	143.2	249	25.9
T_5	:	80% N & K through fertigation with 80% P applied as basal	140.1	245	25.2
T_6	:	80% N through fertigation with 80% P & K applied as basal	139.2	244	25.0
T_7	:	60% NPK through fertigation	124.8	223	21.9
T_8	:	60% N & K through fertigation with 60% P applied as basal	124.0	177	19.5
T_9	:	60% N through fertigation with 60% P & K applied as basal	122.4	174	18.6
T_{10}	:	100% NPK applied in soil (As per recommendation)	127.7	229	24.1
		S. Em. ±	5.99	11.57	1.4
		CD (P= 0.05)	17.4	33.58	4.0
		C.V. %	8.71	9.89	11.46

Table 2: Yield attributes and yield of *Bt.* cotton as influenced by different treatments of fertigation

Treatment			Number of bolls/plant	Boll weight (g)	Seed cotton weight/plant (g)	Seed cotton yield (kg/ha)	Stalk yield (kg/ha)
T_1	:	100% NPK through fertigation	65.30	3.98	264	4237	4823
T_2	:	100% N & K through fertigation with 100% P applied as basal	64.80	3.96	246	3955	4691
T_3	:	100% N through fertigation with 100% P & K applied as basal	63.50	3.93	252	3925	4622
T_4	:	80% NPK through fertigation	62.80	3.86	250	3934	4605
T_5	:	80% N & K through fertigation with 80% P applied as basal	61.45	3.84	249	3942	4528
T_6	:	80% N through fertigation with 80% P & K applied as basal	60.10	3.83	250	3862	4492
T_7	:	60% NPK through fertigation	56.15	3.77	213	3366	4105
T_8	:	60% N & K through fertigation with 60% P applied as basal	53.90	3.74	203	3290	3950
T_9	:	60% N through fertigation with 60% P & K applied as basal	51.75	3.71	191	2999	3541
T_{10}	:	100% NPK applied in soil (As per recommendation)	55.65	3.79	220	3531	4237
		S. Em. ±	3.12	0.10	12.3	205	208
		CD (P= 0.05)	9.05	NS	36	596	603
		C.V. %	10.48	4.96	10.53	11.09	9.53

Yield

Levels of fertigation had marked and favourable influence on growth and yield parameters *viz.* plant height, number of sympodial per plant, number of bolls per plant and seed cotton weight per plant. These favourable influences on these parameters were reflected in cotton yield.

The visible effect of higher levels of fertigation at 100% NPK was promoting the growth and yield parameters of the crop had increased the seed cotton yield. The seed cotton yield linearly increases with the levels of fertigation. Drip fertigation at 100% NPK thorough fertigation (T_1) had recorded a significantly higher seed cotton yield of 4237

kg/ha, but it remained statistically at par with treatment 100% P applied as basal (T_2), 100% N through fertigation with 100% P & K applied as basal (T_3), 80% NPK through fertigation (T_4), 80% N & K through fertigation with 80% P applied as basal (T_5) and 80% N through fertigation with 80% P & K applied as basal (T_6). These results are in conformity with the finding of Nalayini *et al*. (2012) [8] and Hadole *et al*. (2012) [9] However, treatment of 60% N through fertigation with 60% P & K applied as basal (T_9) recorded minimum seed cotton yield of 3531 kg/ha.

Arithmetic inspection of seed cotton yield data revealed that increase to the tune of 19.99%, 12.00% and 11.15% under fertigation treatments of T_1, T_2 and T_3 over soil applied fertilizer treatment (T_{10}), respectively.

Similarly, the application of 100% NPK through fertigation (T_1) noted a significantly higher stalk yield of 4823 kg/ha, but it remained at par with all the treatments of 100% and 80% NPK applied through fertigation. Whereas lower stalk yield was recorded with 60% dose of NPK through fertigation. These results conform with the finding of Solanki *et al*., (2020) [6] and Gawali *et al*., (2020) [2]

Conclusion

The present study revealed that all the treatments of fertigation at 80% dose of NPK (80% NPK through fertigation, 80% N & K through fertigation with 80% P applied as basal and 80% N through fertigation with 80% P & K applied as basal) found optimum for getting higher growth characteristics, yield attributes and yield which was on par with 100% NPK through fertigation and saving the 20% of fertilizer.

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