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Effect of weed management in nutrient uptake and yield of *Bt* cotton (*Gossypium hirsutum* L.) under TBP command area

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Abstract
A field experiment was conducted during *Kharif* of 2018-19 at KVK farm raichur, Karnataka under TBP irrigation command area to study the effect of weed management in nutrient uptake and crop yield. The experiment consists of 11 treatments with three replications. Among all the weed management treatments, significantly higher uptake of nutrients by cotton was recorded in weed free check (155.51N kg ha^{-1}, 45.29 P kg ha^{-1} and 155.41 K kg ha^{-1}) at the same time lower uptake of nutrients by weeds (0 NPK kg ha^{-1}) were also recorded in weed free check, but higher uptake of nutrients by weeds were found in weedy check (84.69 N kg ha^{-1},19.08 P kg ha^{-1} and 89.40 K kg ha^{-1}). Weed free check was recorded higher number of bolls per plant (45 plant^{-1}), higher boll weight (5.74 g) and higher seed cotton yield (2636 kg ha^{-1}) followed by sequential application of herbicides.

Keywords: Boll weight, nutrient uptake and seed cotton yield

Introduction
Cotton is the most important global cash crop and controls economy of many nations. It provides gainful employment to several million people during its cultivation, trade, processing, manufacturing and marketing. Cotton and cotton textile industries are engines of economic growth in both developed and developing countries.

Weed infestation in cotton has been reported to offer severe competition and causing yield reduction to an extent of 50-85 per cent. Weeds not only compete with the crop for nutrients, moisture, light, heat energy and space but also harbor insects and disease organisms and reduce the growth and yield of cotton (Papamichail *et al*., 2002) [8]. In addition, weeds exert stress to the cultivated crops through their allelopathic and parasitism effect and the crop must be kept free from weeds in critical stages to prevent yield loss (Knezevic *et al.*, 2002) [4]. The more acute weed competition effects are noticed from 15 to 55 days after emergence. Therefore, it is very essential to keep the field weed free for about 50 to 60 days after sowing to get optimum yield. To be successful, weed management systems require advance planting and timely execution of weed control practices as any delay in weeding may cause substantial loss of commercial product and increases cost of cultivation.

Material and Methods
A field experiment was conducted during the *Kharif* 2018 at Krishi Vigyan Kendra farm of University of Agricultural Sciences, Raichur, which is situated between 15º14' N latitude and 77º 07' E longitude with an altitude of 389 meters above the mean sea level and it falls within the North Eastern Dry Zone (Zone 2) of Karnataka. The experiment was laid out in randomized complete block design with 11 treatments replicated thrice. The treatments consists of metolachlor 50% EC @ 800 g *a.i* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS, metolachlor 50% EC @ 1000 g *a.i* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS, metolachlor 50% EC @ 1200 g *a.i* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS, metolachlor 50% EC @ 2000 g *a.i* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS, diuron 80% WP @ 1500 g *a.i* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS, pendimethalin 30 EC @ 1250 g *a.i* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS, metolachlor 50% EC @ 1000 g *a.i.* ha-^{1} as PRE *fb* pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS, diuron 80% WP @ 1500 g *a.i.* ha^{-1} as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS,

pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1} as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS, two hand weeding @ 15 and 30 DAS *fb* IC at 45, 60 and 75 DAS and weedy check. The cultivar used in the experiment was Jadoo BG-II is a hirsutum hybrid and sowing was done at August 16 on medium black soil having P^H $_{7.6}$, organic carbon 3.55 g kg^{-1}, Available nitrogen 254 kg ha^{-1}, Available P_2O_5 34 kg ha^{-1}, Available K_2O 299 kg ha^{-1} and having electrical conductivity 0.35 ds m^{-1} and had applied NPK at the rate of 190:80:80. The 25% N and 100% each of P and K was applied at the time of sowing and remaining quantity of N was applied in three equal splits at 50, 80 and 110 DAS in the ring formed 5-10 cm away from the plant and was covered with soil after application. Nitrogen, phosphorous and potassium contents in composite plant samples of cotton at harvest and of weeds at 15, 30, 45, 75 and at harvest were estimated by modified micro-kjeldhal method, vanadomolybdate yellow colour method and flame photometer method, respectively as outlined by Jackson (1967) [3].

Results and discussion

Uptake of nutrients by weeds in *Bt* cotton field as influenced by weed management treatments (Table 1 and Fig. 1)

As the population was high, weedy check removed major NPK from soil. In case of Nitrogen, metolachlor 50% EC @ 800 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS (19.88 kg ha^{-1}) depleted more amount of nitrogen which was significantly inferior to rest of the weed management practices. The higher phosphorous depletion (19.08 kg ha^{-1}) was noticed in weedy check which was significantly inferior to rest of the treatments. The treatments receiving metolachlor 50% EC @ 1000 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10EC @ 125 g *a.i.* ha^{-1} gas POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS, diuron 80% WP@ 1500 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS and pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS exhibited lesser uptake (19.26 kg ha^{-1}, 20.33 kg ha^{-1}, 20.41 kg ha^{-1}) respectively. Potassium uptake was higher in metolachlor 50% EC @ 800 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS (26.22 kg ha^{-1}) which was next to weedy check (89.40 kg ha^{-1}). Maximum removal of nutrients was recorded by weeds under unweeded condition. Weed infestation in cotton has been reported to offer severe competition and causing yield reduction to an extent of 40 to 85 per cent and is primarily due to nutrient depletion caused by weeds and may vary over from 10-90 per cent. But with the application of herbicides, especially with PRE followed by POST managed a large amount of nutrients (NPK) by weeds due to its efficient weed management compared to sole applications. This results are corrugated with the findings earlier reported by Hiremath *et al.*, (2013) [2].

Uptake of nitrogen, phosphorous and Potassium (kg ha^{-1}) by *Bt* cotton as influenced by weed management treatments (Table 1 and Fig. 2)

Bt cotton under weed free condition utilized maximum amount of soil available nitrogen (155.51kg ha^{-1}) followed by metolachlor 50% EC @ 1000 g *a.i.* ha^{-1}as PRE *fb* pyrithiobac sodium 10EC @ 125 g *a.i.* ha^{-1}as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (150.19 kg ha^{-1}), diuron 80% WP@ 1500 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (147.85 kg ha^{-1}) and Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (146.81kg ha^{-1}) in discending order. These were on par with each other and were also significantly superior to rest of the weed management strategies. Expectedly unweeded check had the lowest N uptake (65.60 kg ha^{-1}). Similar trend was observed in phosphorus and potassium uptake by *Bt* cotton. Among the various weed management practices, significantly the higher nutrient uptake by crop plants was recorded in weed free treatment and this was closely followed by the treatment T7 as compared to all rest treatments while the weedy check treatment was noted significantly lower NPK uptake this might be due to the fact that less competition for natural resources and nutrient uptake between crop plants and weed population under weed free treatment and less weed density per metre square. This results are in accordance with the findings reported by Manikandan, 2009.

Yield parameters (Table 2)

The higher and lower number of bolls per plant was observed in (Table 2) weed free check and weedy check (45 plant^{-1} and 19.67 plant^{-1}) respectively. Metolachlor 50% EC @ 1000 g *a.i.* ha^{-1} as PRE *fb* pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (43.87 plant^{-1}) and diuron 80% WP @ 1500 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (42 plant^{-1}) were on par with weed free check. Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (40.67 plant^{-1}) were next best of former treatments. Higher no of bolls depend mainly the suitable environment like weed free and pest free situations which, enhance the growth and development of bolls. Among all the chemical treatments, significantly higher number of bolls were found in treatments applied with sequential application of herbicides as it was more efficient in controlling weeds especially during critical period of weed competition. These results are also described earlier by Patel *et al*. (2013) [9], Mathukia *et al*. (2018) [6] and Nadeem *et al*. (2013) [7].

Significantly higher boll weight (5.74 g) was recorded in weed free check (Table 2). Metolachlor 50% EC @ 1000 g *a.i.* ha^{-1} as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (5.55 g) followed by diuron 80% WP @ 1500 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (5.28 g) and Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (5.26 g) were on par with weed free check. The higher boll weight may be ascribed due to the fact that cotton plant prevailed less competitions to natural resources and also congenial field conditions during growth period as compared to other treatments. These results are in close agreement to the findings reported by Shivashenkaramurthy (2000).

Significantly higher yield (2636 kg ha^{-1}) was observed in (Table 2) weed free check, while Metolachlor 50% EC @ 1000 g *a.i.* ha^{-1} as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (2578 kg ha^{-1}), diuron 80% WP @ 1500 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (2516 kg ha^{-1}) and

Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1}as PRE *fb* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS (2443 kg ha^{-1}) were on par with the weed free check. Rest of the treatments obtained lesser seed cotton yield and very poor in comparison to sequential spray of herbicides coupled with one IC. Significantly lower seed cotton yield (1325 kg ha^{-1}) was recorded when plots were left unweeded. Effective control of weeds by sequential application of herbicides under the above superior treatments might have reduced crop-weed competition for moisture, nutrients and sunlight and ultimately enhanced photosynthetic and metabolic activities in the crop, which reflected in improved growth and development of the crop and finally increased seed cotton yields. Similar results are also reported by Hiremath, 2013, Bharathi *et al*., 2011 and Salimi *et. al*., 2010.

Table 1: Uptake of nitrogen, phosphorous and potassium (kg ha^{-1}) by weeds and crops at *Bt* cotton field as influenced by weed management treatments

Treatments	Uptake of NPK (kg ha^{-1}) by weeds			Uptake of NPK (kg ha^{-1}) by *Bt* cotton		
	N	P	K	N	P	K
T_1 - Metolachlor 50% EC@ 800 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	19.88	4.88	26.22	130.30	32.57	138.66
T_2 - Metolachlor 50% EC @ 1000 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	19.70	4.74	25.48	145.66	40.55	148.22
T_3 - Metolachlor 50% EC @ 1200 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	18.19	4.59	24.52	143.30	38.33	146.41
T_4 - Metolachlor 50% EC @ 2000 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	17.33	4.41	23.52	140.72	37.34	144.63
T_5 - Diuron 80% WP @ 1500 g *a.i.* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS	17.27	4.30	22.36	138.63	36.43	142.74
T_6 - Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	17.26	4.23	21.40	135.99	35.81	140.82
T_7 -Metolachlor 50% EC @ 1000 g *a.i.* ha^{-1}as PRE fb Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60DAS	15.24	2.90	19.26	150.19	44.79	152.87
T_8 -Diuron 80% WP as PRE *fb* @ 1500 g *a.i.* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS	16.63	3.56	20.33	147.85	43.37	152.14
T_9 - Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1} as PRE *fb* Pyrithiobac sodium10 EC @125 g *a.i.* ha^{-1}as POE @ 2-5 leaf stages of weeds *fb* IC @ 60DAS	16.37	3.65	20.41	146.81	42.24	150.56
T_{10} -Two hand weeding @ 15 and 30 DAS *fb* IC at 45, 60 and 75 DAS	0.00	0.00	0.00	155.51	45.29	155.41
T_{11} -Weedy check	84.69	19.08	89.40	65.60	25.11	65.55
S.Em±	1.75	0.23	1.61	4.86	1.68	4.90
CD at 5%	5.16	0.66	4.75	14.34	4.96	14.47

EC- Emulsifiable concentrate WP- Wettable powder IC- Intercultivation
PRE- Pre-emergence POE- Post emergence DAS- Days after sowing

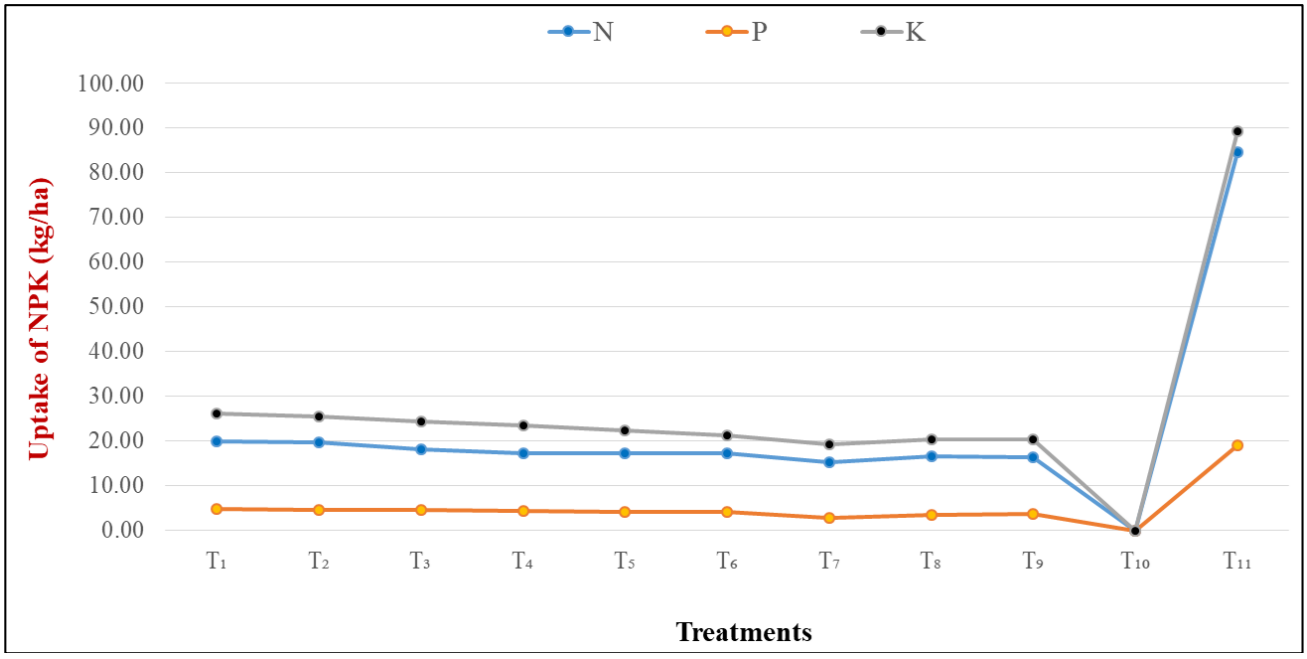

Fig 1: Uptake of nitrogen, phosphorous and potassium (kg/ha) by weeds

Table 2: Effect of weed management treatments in total number of bolls, Boll weight (g) and Seed cotton yield (kg ha^{-1}) of *Bt* cotton field

Treatments	Total number of bolls	Boll weight (g)	Seed cotton yield (kg ha^{-1})
T_1 - Metolachlor 50% EC@ 800 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	25.00	4.37	1648
T_2 - Metolachlor 50% EC @ 1000 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	36.93	4.91	2005
T_3 - Metolachlor 50% EC @ 1200 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	34.67	4.89	1996
T_4 - Metolachlor 50% EC @ 2000 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	32.20	4.71	1864
T_5 - Diuron 80% WP @ 1500 g *a.i.* ha^{-1} as PRE *fb* IC @ 45 and 60 DAS	28.67	4.76	1734
T_6 - Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1}as PRE *fb* IC @ 45 and 60 DAS	29.67	4.75	1808
T_7 -Metolachlor 50% EC @ 1000 g *a.i.* ha^{-1}as PRE fb Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60DAS	43.87	5.55	2578
T_8 -Diuron 80% WP as PRE *fb* @ 1500 g *a.i.* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS	42.00	5.28	2516
T_9 - Pendimethalin 30 EC @ 1250 g *a.i.* ha^{-1} as PRE *fb* Pyrithiobac sodium10 EC @125 g *a.i.* ha^{-1}as POE @ 2-5 leaf stages of weeds *fb* IC @ 60DAS	40.67	5.26	2443
T_{10} -Two hand weeding @ 15 and 30 DAS *fb* IC at 45, 60 and 75 DAS	45.00	5.74	2636
T_{11} -Weedy check	19.67	4.16	1325
S.Em±	1.29	0.19	97.01
CD at 5%	3.81	0.55	286.17

EC- Emulsifiable concentrate WP- Wettable powder IC- Intercultivation
PRE- Pre-emergence POE- Post emergence DAS- Days after sowing

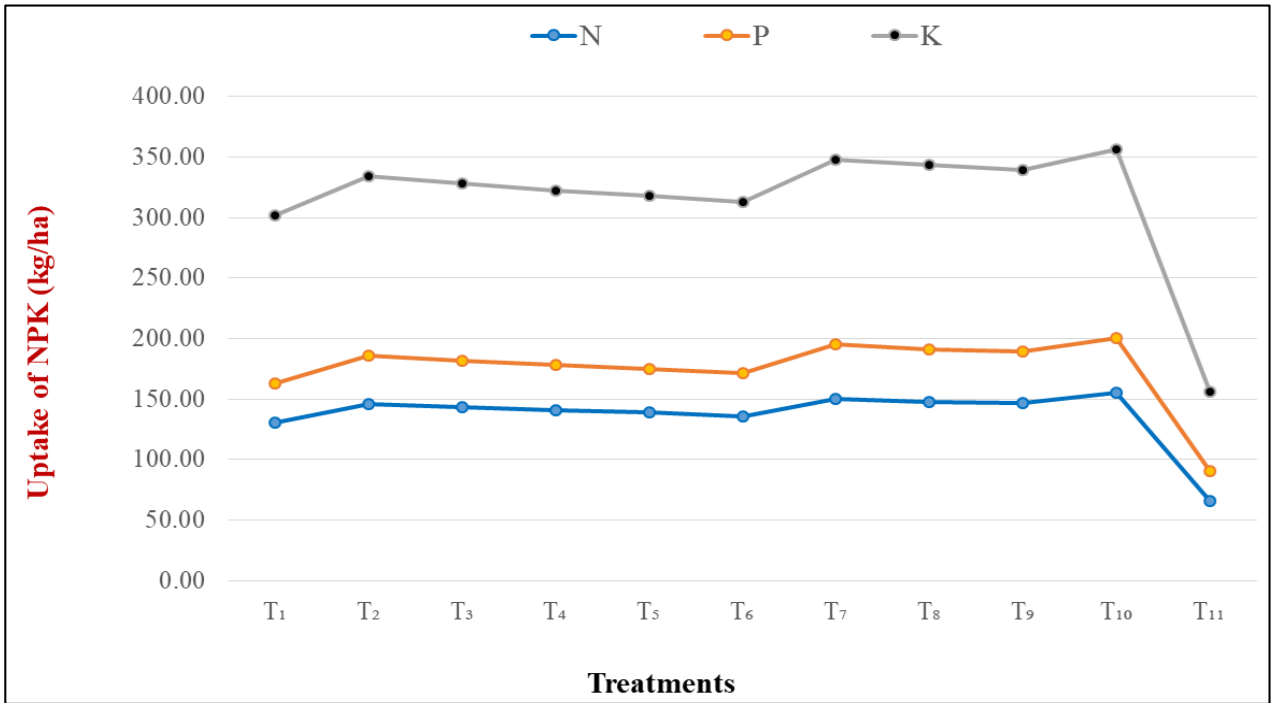

Fig 2: Uptake of nitrogen, phosphorous and potassium (kg/ha) by *Bt* cotton

Conclusion

The present study investigated that weed free check can provide best control to the weed species and maintain better crop growth situations to utilize properly the nutrients present and applied in the field. But due to the increasing crisis of labour scarcity, sequential application of herbicides using (Metolachlor 50% EC @ 1000 g a.i. ha^{-1}, diuron 80% WP @ 1500 g a.i. ha^{-1} as PRE fb Pyrithiobac sodium 10 EC @ 125 g a.i. ha^{-1} as POE @ 2-5 leaf stages of weeds fb IC @ 60 DAS, diuron 80% WP as PRE *fb* @ 1500 g *a.i.* Pyrithiobac sodium 10 EC @ 125 g *a.i.* ha^{-1} as POE @ 2-5 leaf stages of weeds *fb* IC @ 60 DAS and Pendimethalin 30 EC @ 1250 g a.i. ha^{-1}as PRE fb Pyrithiobac sodium 10 EC @ 125 g a.i. ha^{-1} as POE @ 2-5 leaf stages of weeds fb IC @ 60 DAS) was found to be viable treatment and were recorded seed cotton yield.

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