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# STUDY THE EFFECT OF DIFFERENT INTERCROPS ON WEEDS AND NUTRIENT UPTAKE AND POST-HARVEST NUTRIENT STATUS OF *Bt* COTTON PRODUCTION SYSTEM UNDER VIDARBHA CONDITIONS

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**Abstract:-**

A field experiment was conducted to study "Multi-tier cropping system to enhance resource utilization, productivity and profitability of *Bt* cotton production system" at Cotton Research Unit, Dr. PDKV, Akola during *kharif* season of 2021-22. The experiment was laid out in Randomized Block Design with nine treatments and three replications. The variety of cotton PDKV JKAL-116 *Bt* (BG-II) was used for sowing with 60-120-60 cm paired row spacing and intercrops like greengram (Kopergaon), blackgram (AKU -10-1), soybean (JS 9305), and pigeonpea (PKV-TARA) genotypes were used for sowing. Experimental results revealed that sole *Bt* cotton registered significantly higher yield attributes as compared to other paired row planting of cotton with different intercrops. Cotton is slow growing in nature and widely spaced too, it creates suitable conditions for an increased weed competition in the crop. As a result, during the investigation sole cotton grown at 90x60cm row spacing recorded significantly a greater number of weeds from initial stage up to harvest as compared to other intercropping system in paired row cotton. The total uptake of nitrogen, phosphorus and potassium was also recorded significantly higher in sole *Bt* cotton than the paired row planting of cotton with different intercrops. Among the various treatments, the planting of cotton with pigeonpea in (6:2) row pattern and cotton + greengram (1:1) being at par with sole *Bt* cotton in respect to total uptake of nitrogen, phosphorus and potassium.

**Key words:** *Bt* cotton, Intercrop, Weed, Paired row, Nutrient, Uptake.

## Introduction

Cotton (*Gossypium hirsutum* L.) belonging to family Malvaceae, is one of the important commercial crops of our country, often referred as the "The White Gold" or "The King of Fibre" which plays a vital role in the Indian economy. Maharashtra is the leading state in respect of cultivated area (41.84 lakh

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hectare) under cotton cultivation, which contribute to 32.28% of total cotton growing area of the country (129.60 lakh hectare) but ranks second in production (86 lakh bales) (which is 17% of the production) next to Gujarat (90.50 lakh bales) and 9$^{th}$ in productivity 319 kg ha$^{-1}$ (3). Vidarbha shares 39.62% area (15.08 lakh hectare) and 44% of total production of Maharashtra with an average productivity of 300 kg ha$^{-1}$. Main reason for low productivity in Maharashtra and Vidarbha is most of the cotton production is under rainfed condition.

Cotton is a crop of relatively longer duration; its slow initial growth offers a vast scope for cultivation of suitable intercrops including short duration pulses. Intercropping system having scope in better utilization of growth resources like nutrient, water, light, air, component crop taken as intercrop for get additional income. Intercropping having quick growing habit and covers the area which suppress the weed growth. Multi-tier cropping is a system of growing together, crops of different heights at the same time on the same piece of land and thus using land, water and space most efficiently and economically. In multi-tier systems, the possibility of more efficient use of resources like sunlight, nutrients and water is leading to increased biological diversity and higher production stability. Intercrops were observed to serve as an insurance against the menace of pest and disease, vagaries of weather, market fluctuation and help to increase the net profit to farmers. Intercropping of legumes is an important aspect for biological farming system not only for weed control, but also in reducing the leaching of nutrients, pest control and in reducing soil erosion (7).

Cotton is grown prominently as a rainfed crop in Vidarbha. Major causes of low productivity of cotton in Vidarbha are erratic behavior of rainfall, growing of cotton on marginal and sub marginal land and less adoption of improved technologies. Drought conditions during flowering and boll development stage adversely affects the growth and later the shedding of reproductive parts resulting in low crop yield. Important ways to increase productivity are to provide good drainage, soil management practices for moisture conservation, planting or cropping system, intercultural operations, nutrient management and plant protection measures, etc. For risk aversion in rainfed farming, multi-tier or intercropping in cotton is advocated instead of sole cropping. Cotton has initially slow growth habit and *Bt* hybrids grown at wider row spacing can be utilized for intercropping. The wider space in between the rows of cotton can effectively be utilized for growing short duration, compact and quick

growing crops like greengram, blackgram, soybean, pigeonpea, etc.

**Materials and Methods**

The field experiment was conducted at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season of 2021-22. The topography of experimental plot was fairly uniform and levelled. The soil was black cotton belonging to vertisol. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatment combinations.

The variety of cotton PDKV JKAL-116 *Bt* (BG-II) was planted. The crop variety and seed rate were used as per the recommendations for sole crop. The quantity of seed for greengram, blackgram, soybean and pigeonpea as an intercrop was calculated on the area basis and sown. Sowing was done by dibbling to a proper depth by keeping the distance of 60-120-60 cm between plants and rows with one seed per hill and seed is covered with moist soil in net plots measuring 5.4 m x 4.2 $m^2$. In order to avoid crop-weed competition at seedling stage, the application of pre-emergence herbicide Pendimethalin was done @ 1kg a.i. $ha^{-1}$. Two hoeing were given so as to keep the crop weed free, to keep the soil loose and porous for good aeration and well establishment of root system and for satisfactory growth of crops. Three hand weeding were carried out during the crop period so as to crop weed competition and to maintain the experiment plot weed free. The cotton crop was fertilized with the recommended dose of 60:30:30 NPK kg $ha^{-1}$. The source of nutrient used was by Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP). Fertilizers were mixed thoroughly in required quantity and placed in the soil at 3-5 cm deep and away from the seed.

For weed population and weed dry matter study in each net plot, a quadrate of 1×1 m area was randomly fixed. Number of weeds observed in that area was counted at 30 days' interval and finally at harvest of the crop. These weeds were grouped as monocot and dicot weeds. The weeds were first air dried and then kept in an oven at $65^0$C till the constant dry weight was obtained. These observations were taken periodically at 30, 60, 90,120 DAS and at harvest was recorded prior to implementation of weed control measures scheduled at respective stage in different treatments. Weed smothering efficiency was worked out by using the formula suggested by (1). It denotes how effectively the intercrops suppress weeds.

The composite soil sample (0-30 cm depth) from each net experimental plot was collected after the harvest of the crop. The sample were air dried in shade, powdered and analyzed for estimation of available nitrogen,

phosphorus and potassium contents of the soil. The available nitrogen from the soil is estimated by alkaline permanganate method by using microprocessor based automatic distillation system (14). The available phosphorous from the soil was determined by Olsen's method. The available potassium from the soil was determined by neutral normal ammonium acetate extract using flame photometer (6). The plants removed for dry matter study at 50% boll bursting stage were used for estimation of nitrogen, phosphorus and potassium content.

The plants were dried, grinded to fine powder and used for estimation of nitrogen, phosphorus and potassium by micro Kjeldahl's method, Colorimetric method and Photometer method respectively.

**Results and Discussion**

Data presented in Table-1 reveals that there is an influence of grain legumes as intercrop with paired row planting of cotton on weed population. As cotton is slow growing in nature and widely spaced too, it creates suitable conditions for an increased weed competition in the crop.

**Table 1. Weed count ($m^2$), weed dry matter (g $m^{-2}$) and weed smothering efficiency (%) of cotton as influenced by different treatments.**

| Treatments | Weed count (number) | Weed dry matter (g $m^{-2}$) | Weed smothering efficiency (%) |
|---|---|---|---|
| T1 – Sole *Bt* cotton | 49.18 | 113.11 | - |
| T2 – Paired row planting of *Bt* cotton with two rows of Greengram | 24.21 | 60.53 | 46.49 |
| T3 – Paired row planting of *Bt* cotton with two rows of Blackgram | 29.84 | 74.61 | 34.04 |
| T4 – Paired row planting of *Bt* cotton with two rows of Soybean | 33.47 | 83.68 | 26.02 |
| T5 – Paired row planting of *Bt* cotton with one row of Greengram + one row of Blackgram | 28.60 | 71.51 | 36.78 |
| T6 – Paired row planting of *Bt* cotton with one row of Blackgram + one row of Soybean | 23.64 | 59.09 | 47.76 |
| T7 – Paired row planting of *Bt* cotton with one row of Soybean + one row of Greengram | 28.87 | 72.18 | 36.19 |
| T8 – Cotton + Pigeonpea (6:2) (90×60 cm) | 39.38 | 94.52 | 16.44 |
| T9 – Cotton + Greengram (1:1) (90×60 cm) | 20.05 | 52.13 | 53.91 |
| **SE (m)±** | **2.53** | **6.29** | - |
| **CD at 5%** | **7.59** | **18.85** | - |
| **GM** | **30.80** | **75.70** | - |

As a result, during the investigation sole cotton grown at 90x60cm row spacing recorded significantly a greater number of weeds from initial stage up to harvest as compared to other intercropping system in paired row cotton except cotton + pigeonpea (6:2) might be due to wider spacing.

Weed population comprising of grasses, sedges and broad-leaved weeds were found to be significantly reduced under different intercrops grown in paired row cotton due to suppressive effect on weed growth and smothering effect of different intercrops. In intercropping system there was 10.76% to 72.88% weed reduction as compared to sole cotton. Lowest weed population (10.18 to 20.05 weeds per $m^2$) was recorded in cotton+greengram at 1:1 row proportion from initial stage up to harvest. Greengram and blackgram showed superior in reducing weed population as compared to soybean and Pigeonpea (2,8 & 13).

The data revealed that during crop growing period maximum mean dry matter was recorded at harvest (75.70 $gm^{-2}$). Due to slow growing in nature and widely spaced in the cotton crop, it creates suitable conditions for an increased weed competition. The sole cotton resulted significantly more weed dry matter (113.11 g $m^{-2}$) as compared to other intercropping system. Due to suppressive effect on weed growth and smothering effect of different intercrops the weed dry weight found to be significantly reduced under different intercrops grown in paired row cotton. Greengram and blackgram showed better in reducing weed dry matter as compared to soybean and Pigeonpea. Lowest weed dry matter (52.13 g) was found in cotton + greengram at 1:1 row proportion (2,9 & 10).

*Bt* cotton is a widely spaced crop and it takes at least 90 days to cover the land area. The interspaces between cotton rows are occupied by weeds and compete with crop for nutrient, moisture, light and space and also act as alternate host for pest and disease. One of the best approaches for reducing problems caused by weeds is increasing the crop density either of sole crop or intercrop. Shading the top soil and competition for water and nutrients will certainly suppress weed germination and growth of weeds in intercropping system. Weed smothering efficiency was influenced by multitier intercropping system. During the year of study, cotton intercropped with one row of greengram (T9) registered the maximum weed smothering efficiency of 53.91% followed by the treatment (T6) paired row planting of *Bt* cotton with one row of blackgram and one row of soybean 47.76%. Paired row planting of *Bt* cotton with two rows of greengram (T2) also having good weed smothering efficiency 46.49% than other combination of intercrops.

High foliage producing capacity of intercrops, suppressed the weed growth. The minimum weed smothering efficiency was recorded in the treatment of (T8) cotton + pigeonpea in (6:2) row proportion i.e. 16.44%.

Available nitrogen in soil was recorded significantly higher in different treatments of intercrops and found to be at par with each other. Among the various intercropping system, cotton + greengram at 1:1 row proportion (221.82 kg ha-¹), paired row cotton intercropped with two rows of greengram (221.10 kg ha-¹) and paired row of cotton with two rows of blackgram (218.99 kg ha-¹) recorded significantly higher available nitrogen in the soil as compared to sole cotton (208.55 kg ha-¹). Sole cotton recorded lower available nitrogen as compared to rest of the treatments. Increase in available nitrogen in

**Table 2. Available N, P and K (kg ha$^{-1}$) after harvest as influenced by different treatments**

| Treatments | Available N ( kg ha$^{-1}$) | Available P ( kg ha$^{-1}$) | Available K ( kg ha$^{-1}$) |
|---|---|---|---|
| T1 – Sole *Bt* cotton | 208.55 | 21.67 | 344.89 |
| T2 – Paired row planting of *Bt* cotton with two rows of Greengram | 221.10 | 23.83 | 348.97 |
| T3 – Paired row planting of *Bt* cotton with two rows of Blackgram | 218.99 | 22.42 | 346.02 |
| T4 – Paired row planting of *Bt* cotton with two rows of Soybean | 212.97 | 20.63 | 334.46 |
| T5 – Paired row planting of *Bt* cotton with one row of Greengram + one row of Blackgram | 219.45 | 22.73 | 350.71 |
| T6 – Paired row planting of *Bt* cotton with one row of Blackgram + one row of Soybean | 218.49 | 20.89 | 343.67 |
| T7 – Paired row planting of *Bt* cotton with one row of Soybean + one row of Greengram | 218.55 | 21.87 | 339.43 |
| T8 – Cotton + Pigeonpea (6:2) (90×60 cm) | 214.97 | 21.23 | 351.98 |
| T9 – Cotton + Greengram (1:1) (90×60 cm) | 221.82 | 22.91 | 346.97 |
| **SE (m)±** | **2.12** | **0.77** | **3.16** |
| **CD at 5%** | **6.36** | **NS** | **9.47** |
| **GM** | **217.21** | **22.02** | **345.23** |

The relevant data on available nitrogen, phosphorus and potassium status of soil (kg ha$^{-1}$) after harvest as influenced by different treatment are presented in Table 2. The initial available nitrogen, phosphorus and potassium status of soil was 210, 17.90 and 345 kg per hectare respectively. After harvest it was recorded 217.21, 22.02 and 345.23 kg N, P and K per hectare respectively.

soil might be associated with biomass added by intercrops and biological nitrogen fixation by intercrops.

Available phosphorus in soil was found non-significant in different treatments. However, numerically the treatment of paired row planting of *Bt* cotton with two rows of greengram (T2) recorded that higher available phosphorus (23.83 kg ha-¹). Available potassium in soil was recorded significantly higher in different treatments of intercrops and found to be at par with each other. Treatments of cotton + pigeonpea (6:2) intercropping system i.e. T8 was recorded higher value of available potassium (351.98kg ha-¹) was found found superior over the sole cotton. The paired row planting of *Bt* cotton with two rows of soybean (T4) recorded lower available potassium (334.46 kg ha-¹) as compared to rest of the treatments. The higher nutrient status was noticed in most of the intercropping treatment as compared to sole cotton. Inclusion of legumes as an intercrop in cotton play a multi beneficiary role by providing grains and improved nitrogen status of soil through fixation of atmospheric nitrogen. Thus, growing of legumes as an intercrop was beneficial to soil health and soil fertility. (4 & 5) reported that, residual nitrogen was improved in leguminous intercropping systems

**Table 3. Nutrient uptake (kg ha$^{-1}$) by the cotton after harvest as influenced by different treatments**

| Treatments | Nutrient Uptake (kg ha$^{-1}$) | | |
|---|---|---|---|
| | Nitrogen | Phosphorus | Potassium |
| T1 – Sole *Bt* cotton | 65.95 | 15.58 | 42.73 |
| T2 – Paired row planting of *Bt* cotton with two rows of Greengram | 57.49 | 12.77 | 37.00 |
| T3 – Paired row planting of *Bt* cotton with two rows of Blackgram | 51.71 | 11.45 | 33.73 |
| T4 – Paired row planting of *Bt* cotton with two rows of Soybean | 48.44 | 9.58 | 31.66 |
| T5 – Paired row planting of *Bt* cotton with one row of Greengram + one row of Blackgram | 54.17 | 11.59 | 34.80 |
| T6 – Paired row planting of *Bt* cotton with one row of Blackgram + one row of Soybean | 48.09 | 9.79 | 31.04 |
| T7 – Paired row planting of *Bt* cotton with one row of Soybean + one row of Greengram | 53.94 | 11.21 | 34.27 |
| T8 – Cotton + Pigeonpea (6:2) (90×60 cm) | 54.63 | 12.55 | 35.92 |
| T9 – Cotton + Greengram (1:1) (90×60 cm) | 63.19 | 14.21 | 41.06 |
| **SE (m)±** | **2.10** | **0.64** | **1.56** |
| **CD at 5%** | **6.30** | **1.91** | **4.67** |
| **GM** | **55.29** | **12.08** | **35.80** |

as compared to cotton alone as well as non-legume intercropping systems.

Stalk and seed of cotton were analyzed for calculating nutrient uptake (kg $ha^{-1}$) by plant. Data on percent nitrogen, phosphorus and potassium content in cotton seed and stalk, uptake in seed and stalk and total uptake by plant as influenced by different treatments are presented in **Table 3.** On an average 55.29 kg nitrogen, 12.08 kg phosphorus and 35.80 kg potassium were removed by *Bt* cotton from the soil. The uptake of major nutrients by the crop is a function of crop dry matter accumulation and nutrient availability and nutrient concentration in plants.

Multitier intercropping systems are highly intensive in nature and their impact on productivity of the soil needs to be assessed. During the year of study, nutrient uptake and post-harvest nutrient status were varied significantly. Higher total nitrogen (65.95 kg ha-¹), phosphorus (15.58 kg ha-¹) and potassium (42.73 kg ha-¹) uptake were significantly recorded in sole cotton over all other paired row planting of cotton with intercropping treatments. However, N, P, and K uptake of cotton was higher where cotton was intercropped with pigeonpea, greengram, blackgram than soybean crop. The increase in nitrogen uptake in sole cotton might be due to more nitrogen content and higher dry matter accumulation as well as lack of interspecific competition and more availability during the growth period might have resulted in higher nitrogen content in sole cotton thereby, more uptake and concentration of nitrogen in tissue increased. The lower nitrogen uptake was due to lower dry matter accumulation.

Due to more dry matter accumulation in sole cotton and greater availability of nitrogen, phosphorus and potassium resulted increase in nutrients uptake by cotton in sole cotton. Intercropping of cotton with pigeonpea at 6:2 row proportion and cotton with greengram at row ratio of 1:1 also showed considerably higher uptake of nitrogen, phosphorus and potassium. Similar results reported that sole cotton recorded highest nutrient uptake as compared to the cotton intercropped with greengram, blackgram, pigeonpea and soybean(4, 11 & 12).

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