



International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

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www.agronomyjournals.com

2024; SP-7(8): 491-494

Received: 01-05-2024

Accepted: 04-06-2024

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To study economics of weed control management practices in cotton (*Gossypium hirsutum* L.) - Chickpea (*Cicer arietinum* L.) cropping sequence

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DOI: <https://doi.org/10.33545/2618060X.2024.v7.i8Sg.1307>

Abstract

This study was carried out at cotton research scheme farm, Vasantnao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S) during 2018-19 and 2019-20 under irrigated condition (drip) to study the herbicide residue effect on yield parameters in succeeding chickpea crop. In the experiment seven treatments with three replication was laid out in a randomized block design. Chickpea was sown as a succeeding crop on the same field after harvesting of cotton without disturbing the design without practicing any weed control methods. Significant residual effect of different herbicides were observed on yield parameters of succeeding crop. The yield attributes viz., pods plant⁻¹, seed pod⁻¹ and grain pod⁻¹ were differentially influenced by residual effect of weed management during both the years of study. The pooled results revealed that POE pyriithiobac sodium @ 62.5 g ai/ha + quizalofop ethyl @ 50 g ai/ha at 30 DAS followed by one hand weeding at 60 DAS recorded the highest grain yield (1912 kg ha⁻¹), biological yield (4479 kg ha⁻¹) and harvest index (42.68%).

Keywords: Residual effect, yield parameters, chickpea, grain yield, pods plant⁻¹, biological yield and harvest index

Introduction

Chickpea (*Cicer arietinum* L.) is an important food plant in India, Africa, Central and Southern America. India is the largest chickpea producing country with a 75% share of global production (FAO, 2016). The name chickpea is derived from the French 'chiche' and Latin 'cicer', which is Latin for chickpea. The word chickpea was first found in English print in 1338, which later cited by mid-18th century dictionaries. India accounts for 64% of chickpea production as of 2016, producing 7.1 million tons of chickpea. The seeds are high in fibre, protein and are a good source of iron, phosphorous and folic acid. It is a multi-functional crop, has an important role in the diet of poor who cannot afford to buy animal products. For human consumption, chickpea is nutrient dense, providing more than 20% daily value of protein, dietary fibre and minerals like iron and phosphorous. They are often made in to snacks, ground in to hummus, or canned whole for the salad market. It has a symbiotic association with nitrogen fixing bacteria and can be rotated with nitrogen- intensive crops such as cereals to improve soil conditions. Deep and tap root system of chickpea is known to help in opening up of the soil to the deeper strata, ensuring better texture and aeration of the soil for next crop.

Materials and Methods

A field experiment entitled "Effect of weed control methods on productivity of Bt cotton (*Gossypium hirsutum* L.) – chickpea (*Cicer arietinum* L.) cropping sequence" was conducted during 2018-19 and 2019-20 at experimental farm of Cotton Research Scheme, Vasantnao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.). The soil of experimental plot was low in available nitrogen (198.6 and 202.4 kg ha⁻¹), low in phosphorus (17.52 and 18.32 kg ha⁻¹), high in available potassium (588.50 and 596.18 kg ha⁻¹) and alkaline (pH 8.14 and 8.16) in reaction during 2018-19 and 2019-20, respectively. The soil was clayey in texture with moderate moisture holding capacity which was good for normal growth of the crop.

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The experiment was laid out in a randomized block design with seven treatments in three replications. The treatments comprised: T₁ – PE pendimethalin @ 0.75 kg a.i. ha⁻¹ fb one hand weeding at 60 DAS, T₂ –PE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ fb one hand weeding at 60 DAS, T₃–PE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ fb quizalofop ethyl @50 g a.i. ha⁻¹ at 60 DAS, T₄–POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS fb one hand weeding at 60 DAS, T₅ –POE paraquat dichloride (directed spray) 24 % SL @ 0.5 kg a.i. ha⁻¹ at 30 DAS fb one hand weeding at 60 DAS, T₆ – Weed free, T₇ – Weedy check. Parbhani is located at 19.27° North Latitude and 76.78° East Longitude and has an average elevation of 347m from sea level. It comes under semi - arid region receiving maximum rainfall from south west monsoon and climate is tropical. The maximum temperature was 41.1 °C and 40.9 °C whereas lowest minimum temperature was 7.9 °C and 12.3 °C during 2018-19 and in 2019-20, respectively. The morning and evening mean relative humidity was 71 to 92 percent in 2018-19 and 94 to 66 percent in 2019-20, respectively. The total rainfall during the experimental period was 781.4 mm which was spread over 26 rainy days in 2018-19 and 1029.1 mm which was spread over 62 rainy days in 2019-20. The distribution of rainfall was normal for growth of cotton crop. In general, the climatic conditions were favourable for the cotton growth. Due to sufficient moisture in soil received through rainfall at seedling stage the growth was satisfactory. There was even distribution of rainfall during the crop growth, protective irrigations at critical growth stages of crop were given. The yield level of cotton crop was good. The evaporation ranges between 2.4 to 11.4 mm day⁻¹ in 2018-19 and 2.1 to 10.4 mm day⁻¹ in 2019-20. Chickpea was sown on 1st Dec 2019 during 48th week meteorological week. The fertilizers were applied as recommended dose *i.e.*, 25:50:00 (N: P: K) kg ha⁻¹. As chickpea is a leguminous crop, full dose of fertilizer was applied as basal dose. Three irrigation at pre- sowing, flowering and pod development stage were given. Chickpea crop was harvested on 28.3.2019 and 27.3.2020 when plants started drying to pale colour, leaves started shedding and pods turned yellowish dark brown and dried. The harvested produce was sundried for 2 to 3 days and then it was threshed treatment wise separately. The plants from each net plot were harvested and seeds were separated from pods by threshing. After sun drying, seed yield obtained in each net plot was weighed in kg and converted into seed yield kg ha⁻¹. The harvest index was calculated by dividing seed yield hectare⁻¹ by total biological yield and expressed in percentage.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Results and Discussion

Gross monetary returns

Maximum gross monetary returns (Rs. ha⁻¹) of 66360 in 2018-19 and 68830 in pooled mean was attained with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) which was at par with weed free (T₆) treatment (Rs. ha⁻¹64517), PE pendimethalin @ 0.75 kg a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₁) and PE pyriithiobac sodium @ 62.5 g a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₂) and significantly higher with all other weed management practices. In 2019-20, maximum gross monetary returns (Rs. ha⁻¹ 73100) was attained with weed free (T₆) treatment which was at par with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g

a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) (Rs. ha⁻¹ 71299), PE pendimethalin @ 0.75 kg a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₁) (Rs. ha⁻¹ 65946) and PE pyriithiobac sodium @ 62.5 g a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₂) and significantly higher as compare to all other weed management practices. Weedy check (T₇) recorded the lowest gross monetary returns (Rs. ha⁻¹) of 45017. In pooled analysis, maximum gross monetary returns (Rs. ha⁻¹ 68830) was attained with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) which was at par with weed free (T₆) treatment, PE pendimethalin @ 0.75 kg a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₁) (Rs. ha⁻¹ 65946) and PE pyriithiobac sodium @ 62.5 g a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₂) and significantly higher as compare to all other weed management practices. Weedy check (T₇) recorded the lowest gross monetary returns (Rs. ha⁻¹) 43299.

Table 1: Residual effect of weed management practices on gross monetary returns (Rs. ha⁻¹) and net monetary returns of chickpea during 2018-19, 2019-20 and in pooled

Treatment	GMR (Rs. ha ⁻¹)			NMR (Rs. ha ⁻¹)		
	2018-19	2019-20	Pooled mean	2018-19	2019-20	Pooled mean
T ₁	60713	65946	63330	36113	41036	38575
T ₂	58765	64343	61554	34165	39433	36799
T ₃	54810	59126	56968	30210	34216	32213
T ₄	66360	71299	68830	41760	46389	44075
T ₅	56105	60520	58313	31505	35610	33558
T ₆	64517	73100	68809	39917	48190	44054
T ₇	41580	45017	43299	16980	20107	18544
S.E.(m)+	2666	3592	2358	2666	3592	2358
C.D. at 5%	8216	11069	7268	8216	11069	7268
General mean	57550	62764	60157	32950	37854	35402

Net monetary returns

The data pertaining to chickpea net monetary returns (Rs. ha⁻¹) depicted in Table 1. Chickpea net monetary returns (Rs. ha⁻¹) was significantly influenced by residual effect of weed management practices. Maximum net monetary returns (Rs. ha⁻¹) of 41760 in 2018-19 was attained with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) which was at par with weed free (T₆) treatment followed by PE pendimethalin @ 0.75 kg a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₁) and significantly higher as compare to all other weed management practices. In 2019-20, maximum net monetary returns (Rs. ha⁻¹) 48190 was attained with weed free (T₆) treatment (Rs. ha⁻¹) 48190 which was at par with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) and significantly higher with all other weed management practices. In pooled analysis, maximum net monetary returns (Rs. ha⁻¹) 44075 was attained with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) which was at par with weed free (T₆) treatment and significantly higher as compare to all other treatments.

B: C ratio

The data pertaining to chickpea benefit cost ratio depicted in Table 2. In 2018-19, maximum benefit cost ratio of 2.70 was attained with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ +

quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) which was at par with weed free (T₆) treatment followed by PE pendimethalin @ 0.75 kg a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₁), PE pyriithiobac sodium @ 62.5 g a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₂). In 2019-20, maximum benefit cost ratio of 2.93 was attained with weed free (T₆) treatment which was at par with POE pyriithiobac sodium @ 62.5g a.i. ha⁻¹ + quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS followed by one hand weeding at 60 DAS (T₄) followed by PE pendimethalin @ 0.75 kg a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₁), PE pyriithiobac sodium @ 62.5 g a.i. ha⁻¹ followed by one hand weeding at 60 DAS (T₂). Weedy check recorded the lowest B: C ratio (1.69, 1.81 and 1.75) during 2018-19, 2019-20 and pooled, respectively.

Table 2: Residual effect of weed management practices on pods plant⁻¹, seeds pod⁻¹ and seed weight plant⁻¹ of chickpea during 2018-19 and 2019-20

Treatment	B:C		
	2018-19	2019-20	Mean
T ₁	2.47	2.65	2.56
T ₂	2.39	2.58	2.49
T ₃	2.23	2.37	2.30
T ₄	2.70	2.86	2.78
T ₅	2.28	2.43	2.36
T ₆	2.62	2.93	2.78
T ₇	1.69	1.81	1.75

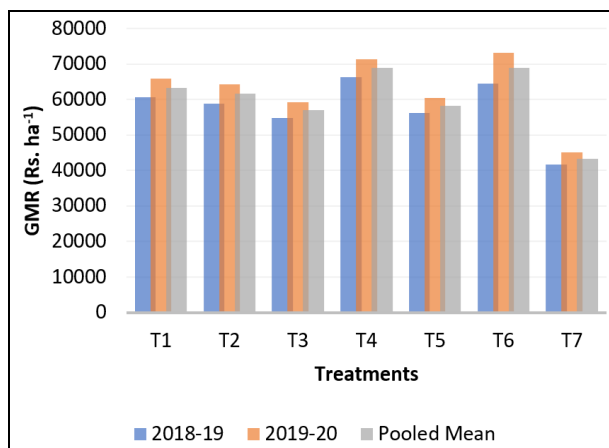


Fig 1: Residual effect of weed management practices on gross monetary returns (Rs. ha⁻¹) of chickpea during 2018-19, 2019-20 and pooled

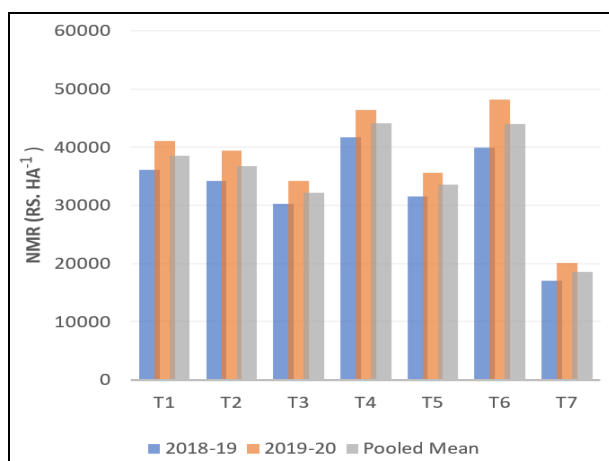


Fig 2: Residual effect of weed management practices on net monetary returns (Rs. ha⁻¹) of chick pea during 2018-19 and 2019-20 and pooled

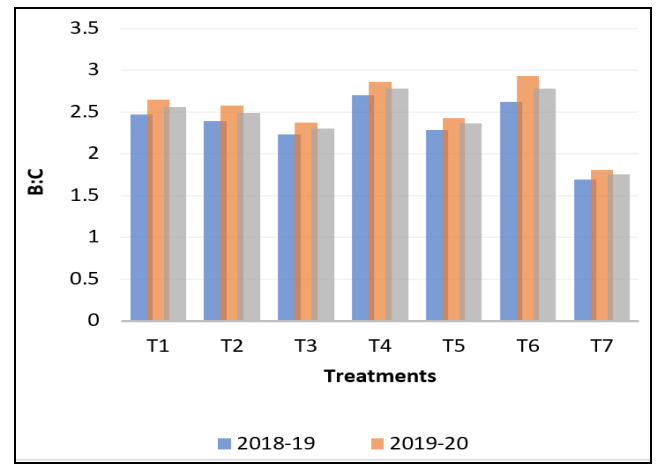


Fig 3: Residual effect of weed management practices on B:C ratio of chickpea during 2018-19 and 2019-20

Conclusion

In conclusion, the weed management practices significantly influenced both gross and net monetary returns and benefit-cost ratios in chickpea cultivation. The highest gross monetary returns of Rs. 68,830 per hectare, as well as the maximum net monetary returns of Rs. 44,075 per hectare in the pooled analysis, were achieved with the application of POE pyriithiobac sodium @ 62.5 g a.i. ha⁻¹ plus quizalofop ethyl @ 50 g a.i. ha⁻¹ at 30 DAS, followed by one hand weeding at 60 DAS. This treatment was comparable to the weed-free scenario but offered a cost-effective alternative. The highest benefit-cost ratio was also noted for this treatment, particularly in the 2019-20 season with a ratio of 2.93. Conversely, the weedy check consistently recorded the lowest returns and benefit-cost ratios. These findings highlight the efficacy of targeted herbicide applications combined with timely weeding in optimizing both financial returns and economic efficiency in chickpea production.

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