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Impact of Weed Control Measures and Tillage Practices on Profitability and Available Soil Nutrients in Chickpea [*Cicer arietinum* L.]

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ABSTRACT: A field experiment entitiled "Weed management in chickpea (*Cicer arietinum* L.) under different tillage practices in trans-gangetic plain region" was conducted for two consecutive *Rabi* seasons of 2022-23 and 2023-24 at Research Farm of Agricultural Research Station, Sriganganagar, Swami Keshwanand Rajasthan Agricultural University, Bikaner. The experiment consisted of twenty eight treatment combinations comprising of four different tillage practices (zero, minimum, conventional and deep tillage) and seven different weed control measures (weed free, weedy check, pendimethalin 750 g/ha PPI, pendimethalin 750 g/ha PE, pendimethalin + imazethapyr 800 g/ha PE, diclosulam 25 g/ha PE and flumioxazin 75 g/ha PE). The experiment was laid out in split plot design with three replications. Chickpea variety GNG-1581 was sown at 30 cm row spacing using 60 kg/ha seed rate. The results of experiment showed that the highest net returns (₹120806/ha) with B:C ratio of 3.42 was obtained in deep tillage over zero and minimum tillage. However, it was at par with conventional tillage and B:C Ratio (4.04) and net return (₹130879/ha) was also higher in pendimethalin + imazethapyr 800 g/ha PE. The organic carbon, available nitrogen, phosphorus and potassium content of soil after harvest of chickpea crop was not affected significantly due to different tillage practices and weed control measures.

Keywords: Net return, deep tillage, zero tillage, minimum tillage, pendimethalin.

INTRODUCTION

Chickpea (*Cicer arietinium* L.) is the most important and often referred to as 'king of pulses'. In India, it occupies an area of 10.91 M ha with a production of 13.75 M t and productivity of 1260 kg/ha (Anonymous, 2021-22). Traditionally, chickpea cultivation is mostly confined to central and northern regions of India, including Madhya Pradesh, Rajasthan, Maharashtra and Uttar Pradesh. Chickpea has played a major role in achieving self-sufficiency in pulses with the so-called pulse revolution in the recent past years (Chaturvedi and Sandhu 2020). The drought hardy nature, low moisture and fertilizer requirement of chickpea make it favourable crop of rainfed areas. Cultivation of chickpea in the rainfed areas is increasing, due to availability of suitable varieties, lower input costs and improving soil fertility. The various factors responsible for low yield are: poor crop stand, weed infestation, inadequate nutrition, rainfed cultivation, pests and diseases. Sowing of chickpea is often delayed due to low soil moisture availability. Adopting traditional practices like repeated ploughings to prepare a fine seed bed for germination and establishment, exposing weed seeds, dormant insect-pests and diseases which may further attack and damage the crop. A bold- seeded crop like chickpea does not require fine tilth and suits well under zero tillage conditions. Zero tillage helps in maintaining soil temperature, enhances soil moisture retention and soil microbial activity to improve soil health (Busari *et al.,* 2015). Conventional tillage can improve the growth and yield of chickpea by creating suitable seed beds, breaking down impermeable soil layers, cleansing soil surface from plant debris and discontinuing the life cycle of insects, weeds and diseases. The practice of no-tillage increases the water permeability and the amount of moisture in soils because of the increase in soil organic matter and the activity of earthworms as compared to conventional tillage systems. Minimum tillage includes, reduced frequency and intensity of tillage operation, use of those implements that loosen the soil without turning over and do not excessively pulverize it and perform the needed tillage operations when soil conditions are within the optimum soil condition range to produce the desired tilth. It facilitates intensive cultivation with minimum risk of degradation. In addition to these, deep tillage has various advantages, like increase in water holding capacity by opening soil to deeper depth and breaking hard pan also. Poor competitive ability of chickpea paves the way for weeds to create yield losses upto 91% under severe infestation (Mukherjee, 2007). Better crop growth and higher yields of chickpea can be harvested when provided with weed-free conditions upto pre-flowering stage (Mohammadi *et al.,* 2005).

Applications of pre-emergence herbicides alone cannot provide season-long weed control and thus the farmers resort to practices like mechanical or manual hand weeding during the early crop growth period. Improper crop management and untimely cultural practices lead to severe economic losses. Common agricultural practices like conventional tillage result in increasing the vertical seed bank after churning the soil. Adopting new generation technologies like conservation agriculture involving zero tillage and minimum tillage, help in preventing weeds to move from deeper to surface layers and reduce the weed population in the long-run. Conservation agriculture is characterized by three principles which are linked to each other, namely; continuous minimum mechanical soil disturbance, continuous organic soil cover, diversified crop rotations in the case of annual crops or plant associations in case of perennial crops (Patode *et al.,* 2021). Besides the influence of weed population, such resource conservation practices have more potential benefits for sustainable crop production and higher yield.

MATERIAL AND METHOD

A field experiment was conducted during *Rabi* 2022-23 and 2023-24 at Agricultural Research Station, Sriganganagar, situated on Karni marg at 28.4 to 33.6°N latitude and 72.2 to 75.3°E longitude at an altitude of 175.6 m above mean sea level. Soil of experimental area was sandy loam in texture, slightly alkaline in reaction (pH 8.1) having organic carbon (0.19%) and available N (125.4 kg/ha), phosphorus (33.5 kg/ha) and high in available K (333 kg/ha). The field experiment on chickpea consisting 4 levels of tillage (zero, minimum, conventional and deep tillage) in main plots and 7 weed management practices (Weed free, weedy check, pendimethalin 750 g/ha PPI, pendimethalin 750 g/ha PE, pendimethalin + imazethapyr 800 g/ha PE, diclosulam 25 g/ha PE and flumioxazin 75 g/ha PE) in sub-plots and comprising a total of 28 treatment combinations which were tested in split plot design with three replications. Chickpea variety 'GNG-1581' which is best suitable for north western plain zone under irrigated conditions, developed by Agriculture Research Station, Sriganganagar in 2007 and potential yield 24 q/ha was sown in row 30 cm apart, using 60 kg/ha seeds. As per the treatment seed bed was prepared after pre-sowing irrigation depending on the main plot treatments. Two harrowing + two ploughings followed by planking were done as preparatory tillage for the conventional tillage. Whereas, for minimum tillage, one harrowing + one cultivator followed by planking were done during both the crop seasons. In case of deep tillage, M.B. plough with 30 cm depth was done. In zero tillage plots, initially no tillage operations were carried out during crop seasons. The required quantity of herbicide i.e. pre plant incorporation pendimethalin was sprayed one day before sowing of chickpea crop in earmarked plots and pre-emergence herbicides (*viz.,* pendimethalin, pendimethalin + imazethapyr, diclosulam and flumioxazin) were sprayed one days after sowing with the help of knapsack sprayer fitted with flat fan nozzle using a spray volume of 500 litre/ha. To find out the profitability of treatments, economics of different treatments were calculated in terms of net returns (₹/ha) so that the most remunerative treatment could be recommended. Treatment wise benefit: cost ratio was calculated to ascertain economic viability of the treatment. The soil samples from each plot were collected after harvest of chickpea crop from surface (0 – 30 cm depth) soil layer. The collected soil samples were dried, powdered and passed through 2 mm sieve. The samples were analyzed for available organic carbon, nitrogen, phosphorus and potassium contents. Tabulation and statistical analysis of data have been done for testing the significance of variation among the different treatments.

Economics

Effect of tillage. Cost of cultivation, net return and B: C ratio varied due to tillage practices (Table 1). The highest cost of cultivation (₹35091/ha) was involved in deep tillage followed by conventional and minimum tillage. Deep tillage gave the highest net return (₹120806/ha) and B: C ratio (3.42) followed by conventional and minimum tillage due to reduction in cost of cultivation in conservation tillage. The data on economics revealed that irrespective of slightly higher cost of cultivation over zero, minimum and conventional tillage, the deep tillage gave the highest net returns of chickpea followed by conventional and minimum tillage whereas least with zero tillage. The highest net return in deep tillage was due to higher grain yields and lower cost of cultivation and it was at par with conventional tillage. Singh *et al.* (2011); Kumar *et al.* (2016) also founds the similar results.

Effect of weed control measures. During both the years of investigation, minimum net returns was fetched under weedy check plots as a result of the lowest seed and straw yield (Table 1). However, pre-emergence application of pendimethalin + imazethapyr 800 g *a.i.* per ha recorded most remunerative, as it fetched the highest net return and B C ratio. The cheap investment under sequential application paired with good economic yield may be the reason for higher net monetary return and B C ratio, even weed free provided the highest net return after pendimethalin + imazethapyr 800 g/ha PE but was nullified due to greater variable cost for weed management. Similar findings were also reported by Dubey *et al.* (2018).

Available soil nutrients

Effect of tillage. The organic carbon, available nitrogen, phosphorus and potassium content of soil after harvest of chickpea crop (Table 2) did not show a perceptible change due to tillage practices during both the years of experimentation. Sharma and Acharya (2000) also reported no significant change in soil organic C, but opined that the effects of conservation tillage may be significant when practised over a long period of time. These results are in close agreement with the findings of Gupta *et al.* (2011); Kumar *et al.* (2014) in wheat.

Effect of weed control measures. The organic carbon, available nitrogen, phosphorus and potassium content of soil after harvest of chickpea crop (Table 2) did not show a perceptible change due to different weed control measures during both the years of experimentation.

Correlation and regression studies. Correlation coefficients and regression equations were worked out between dependent variable *i.e.* seed yield of chickpea (Y) and independent variables *i.e.* yield attributes (X) *viz*. pods per plant (X_1), seeds per pod (X_2), test weight (X_3), total N uptake (X_4), total P uptake (X_5) and total K uptake (X_6). The values calculated are presented in table 3. The results of correlation coefficient revealed that seed yield (Y) was significantly and positively correlated with pods per plant (r= 0.989), seeds per pod (r= 0.849), test weight (r= 0.946), total N uptake (r= 0.993), total P uptake (r= 0.999) and total K uptake (r= 0.985). The regression equations in the same table showed that every unit increase in pods per pod, seeds per pod, test weight, total N uptake, total P uptake and total K uptake increased the seed yield by 82.92, 1652, 81.18, 19.43, 131.39 and 80.15 kg/ha, respectively.

Table 1: Effect of tillage and weed control measures on economics of chickpea.

Treatments	Cost of Cultivation (Rs/ha)	Net returns (Rs/ha	B:C ratio
Tillage			
Zero tillage	28891	91997	3.18
Minimum tillage	32091	95107	2.96
Conventional tillage	34091	115270	3.37
Deep tillage	35091	120806	3.42
SEm±	-	2145	0.07
CD (P=0.05)	-	6610	0.21
Weed control measures			
Weed Free	37192	129653	3.47
Weedy Check	29992	65276	2.19
Pendimethalin 750 g/ha PPI	32092	94660	2.94
Pendimethalin 750 g/ha PE	32092	115171	3.58
Pendimethalin + Imazethapyr 800/ha PE	32342	130879	4.04
Diclosulam 25 g/ha PE	32212	107541	3.34
Flumioxazin 75 g/ha PE	31867	97386	3.05
SEm±	-	2323	0.07
CD (P=0.05)	-	6522	0.20

Table 2: Effect of tillage and weed control measures on soil properties after harvest of chickpea.

Treatments	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Tillage				
Zero tillage	0.192	121.45	31.82	322.02
Minimum tillage	0.193	123.02	32.26	325.72
Conventional tillage	0.194	124.72	32.71	328.74
Deep tillage	0.196	125.79	32.99	331.61
SEm±	0.002	1.72	0.42	4.01
CD (P=0.05)	NS	NS	NS	NS
Weed Control measures				
Weed Free	0.196	126.15	33.08	332.57
Weedy Check	0.191	121.13	31.76	322.19
Pendimethalin 750 g/ha PPI	0.192	122.17	32.03	324.97
Pendimethalin 750 g/ha PE	0.194	124.79	32.72	328.94
Pendimethalin + Imazethapyr 800/ha PE	0.196	125.45	32.90	330.71
Diclosulam 25 g/ha PE	0.194	124.26	32.58	327.53
Flumioxazin 75 g/ha PE	0.192	122.28	32.06	322.24
SEm±	0.002	1.91	0.49	4.72
CD (P=0.05)	NS	NS	NS	NS

Sig = Significant, NS = Non significant

Table 3: Correlation coefficients and linear regression equations showing relationship between independent variables(X) on dependent variable (Y) in wheat.

Dependent variable (Y)	Independent variables (X)	Correlation coefficient (r)	Regression equation Y= a + byx. X
Grain yield (kg/ha)	Pods per plant	0.989**	$Y = 82.929\,x - 668.82\ X_1$
	Seeds per pod	0.849**	$Y = 1652\,x - 29823\ X_2$
	Test weight (g)	0.946**	$Y = 81.182\,x - 9898.8\ X_3$
	Total N uptake	0.993**	$Y = 19.437\,x - 177.61\ X_4$
	Total P uptake	0.999**	$Y = 131.39\,x + 186.63\ X_5$
	Total K uptake	0.985**	$Y = 80.159\,x - 1004.2\ X_6$

**Significant at 1% level of significance

CONCLUSIONS

Based on the results of two year experimentation, it may be inferred that the deep tillage practice and pendimethalin + imazethapyr 800 g/ha PE gave significantly higher net returns and B:C ratio of chickpea. The organic carbon, available nitrogen, phosphorus and potassium content of soil after harvest of chickpea crop was not affected significantly due to different tillage practices and weed control measures.

FUTURE SCOPE

The result of the study will provide the basis for future research to find out the suitable and sustained source of nutrients in standing crop for organic growers in the time of fertilizer crisis.

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Conflict of Interest. None.

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