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Efficacy of weed control treatments on weeds and productivity of chickpea under *Jatropha* based agroforestry

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Abstract

A field experiment was conducted at Research Farm, Department of Forestry, JNKVV, Jabalpur during *Rabi* season 2019-20 to find out the effect of weed management on weeds and productivity of Chickpea under *Jatropha* based Agroforestry. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and 12 herbicidal treatments consisted of Pendimethalin (1000 g ha⁻¹), Imazathaper (900 g ha⁻¹), Atrazine (1000 g ha⁻¹), Metribuzin (300 g ha⁻¹), Oxyflorfen (100 g ha⁻¹), Pendimethalin (500 g ha⁻¹) fb Imazathaper (450 g ha⁻¹), Pendimethalin (500 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹), Metribuzin (150 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹), Atrazine (500 g ha⁻¹) fb Metribuzin (150 g ha⁻¹), Imazathaper (450 g ha⁻¹) fb Atrazine (500 g ha⁻¹), hand weeding (30 DAS) and Weedy check (control). The field was infested with 4 major weed species *Medicago denticulata* Willd., *Vicia sativa* L., *Cynodon dactylon* L., and *Cyperus rotundus* L. Minimum weed density per m² (7.53) and weed dry weight (5.42 q ha⁻¹), was found under hand weeding 30DAS over weedy check. Minimum dry weight of weeds was found under hand weeding (30 DAS) 5.42q ha⁻¹ as compare to weedy check (control) 16.84q ha⁻¹. The highest weed control efficiency was found in hand weeding (30DAS) 89.75%, Pendimethalin (1000 g ha⁻¹) 78.50 %, Atrazine (1000 g ha⁻¹) 67.67 %, Oxyflorfen (100 g ha⁻¹) 66.83 %, and Metribuzin (150 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹) 65.41%. The loss of grain yield was significantly reduced where weeds were control by Pendimethalin (1000 g ha⁻¹) 11.16 %, and Metribuzin (150 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹) 11.19 %. Amongst the different herbicidal treatments higher seed yield was found under Pendimethalin (1000 g ha⁻¹) 12.54 q ha⁻¹, higher stover yield was found under Pendimethalin (1000 g ha⁻¹) 37.46 q ha⁻¹, higher crop biomass was found under Pendimethalin (1000 g ha⁻¹) 50.00 q ha⁻¹ and higher harvest index was found under Pendimethalin (1000 g ha⁻¹) 24.99 % as compared to other treatments. The perusal data showed that higher harvest index was found under hand weeding (30DAS) 25.06 % which was significantly superior over weedy check (control) 18.74 % and rest of the weed control treatments. Pre emergence herbicides and hand weeding can further enhance the weed suppressive effect of the crop under *Jatropha* based Agroforestry.

Keywords: Weeds, herbicides, weed control efficiency, seed yield, harvest index

Introduction

Agroforestry is one of the alternatives for sustainable natural resource management. As a land use system integrating trees or woody perennials, crops and animals, it has been practiced for centuries by farmers. The aim of Agroforestry systems is to increase, diversify and sustain production of economic, environmental and social benefits. Agroforestry practices are considered as most vital and potential farming system for minimizing the land degradation. It enhances soil fertility, reduce erosion and weed infestation, improve water quality, enhance biodiversity, increase aesthetics and sequester carbon. Agroforestry always remain productive for the farmer and generates continuous revenue. With the shrinking per capita land availability, Agroforestry system with the integration of perennial woody trees is most suitable technology for increasing total productivity of food, fodder and fuel and thereby reducing the weed infestation risk of farming. There are many innovative farmers who have developed or modified existing Agroforestry systems to suit local conditions. Tree Born Oil Seeds (TBO) can fit into most of these systems, contributing positively towards the overall productivity and farm income. Initial programs were mainly based on large-scale plantations of *Jatropha* (*Jatropha curcas*) on wastelands, but seed yields proved to be limited and highly variable

under low input regimes, resulting in economic unviability and limited production potential (Achten *et al.*, 2014; van Eijck *et al.*, 2014) [1, 19].

Chickpea (*Cicer arietinum* L.) is one of the most ancient and extensively grown pulse crops of India. In our country, it is mainly cultivated in the state of Madhya Pradesh, Maharashtra, Andhra Pradesh, Rajasthan, and Odisha. India is the largest producer of chickpea accounting to 75% of the world production. Chickpea, being slow in its early growth and short stature plant, is highly susceptible to weed competition and often considerable losses may occur if weeds are not controlled at proper time. Competition of weeds with chickpea assumes more importance as the crop is sown during post-rainy season under rainfed and dry land conditions, thus requires timely and effective weed management. Weeds compete severely with crop for nutrient, moisture, light and space and causes reduction in yield to the extent of 75% in chickpea (Chaudhary *et al.*, 2005) [2]. The herbicides are the plant protection agents which are used in high input agricultural practices to kill the unwanted weeds, thus to prevent yield losses due to these noxious plants (Cork and Krueger, 1992) [3]. To get higher yield it is essential to control weeds at appropriate time with suitable methods. Due to easiness and labour scarcity to control weeds particularly at the critical period, use of herbicides has become very common. There are more than 75 weed species that infest chickpea fields. These species are mostly dicotyledonous and belong to 26 different families (El-Brahli, 1988) [4].

Materials and Methods

A field experiment was conducted at Research Farm Department of Forestry, JNKVV, Jabalpur during Rabi seasons 2019-20 to find out the effects of weed management on weeds and productivity of Chickpea under *Jatropha* based Agroforestry.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and 12 herbicidal treatments consisted of Pendimethalin (1000 g ha⁻¹), Imazathaper (900 g ha⁻¹), Atrazine (1000 g ha⁻¹), Metribuzin (300 g ha⁻¹), Oxyflorfen (100 g ha⁻¹), Pendimethalin (500 g ha⁻¹) fb Imazathaper (450 g ha⁻¹), Pendimethalin (500 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹), Metribuzin (150 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹), Atrazine (500 g ha⁻¹) fb Metribuzin (150 g ha⁻¹), Imazathaper (450 g ha⁻¹) fb Atrazine (500 g ha⁻¹), hand weeding (30 DAS) and Weedy check (control). The soil of the experimental field was silty clay loam in texture, high in available nitrogen (326 kg N ha⁻¹), low in phosphorus (23.99 kg P₂O₅ ha⁻¹) and potassium (136 kg K₂O ha⁻¹) content respectively. The soil was found slightly alkaline (pH 7.7) in reaction. Chickpea JG-12 variety was sown on 16th November, 2019 at row spacing of 30 cm by using 80 kg ha⁻¹ seed rate with (20: 60: 20 NPK kg ha⁻¹). All the quantity of NPK was applied at the time of sowing as basal application. Weed population was counted with the help of quadrat (0.50 m X 0.50 m) thrown randomly at four places in each plot and converted in to m² area. The weed dry matter was recorded from the quadrates after cutting weeds from the ground level and then oven dried at 70°C and converted to m². The data on weeds were subjected to square-root transformation before statistical analysis. The observation on weeds and crop yield were recorded in all the treatments at the time of harvest. Harvest index was calculated as the ratio of grain yield to the biological yield. It was calculated as per the formula proposed by Nichiporovich (1967) [13].

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The weed control efficiency (WCE)

The weed control efficiency (WCE) of the treatments against weedy check was calculated on the basis of weed dry weight as suggested by Mani *et al.* (1973) [9].

$$\text{WCE (\%)} = \frac{\text{WD}_c - \text{WD}_t}{\text{WD}_c} \times 100$$

Where, WCE= Weed control efficiency, WD_c = Dry weight of weeds in unweeded control plot

WD_t = Dry weight of weeds in treated plot.

Weed index

Weed index of each treatment was calculated by using following formula (Gill and Kumar, 1969) [5].

$$\text{Weed index (\%)} = \frac{X - Y}{X} \times 100$$

Where, X = Yield from hand weeded plot

Y = Yield from the treatment for which weed index is to be worked out

Weed count were subjected to square root transformation $\sqrt{X+0.5}$. All the experimental data were statistically analyzed and critical difference (CD) was worked out by the procedure as described by Gomez and Gomez (1984) [6].

Result and discussion-

Weed flora

The weed flora comprised of both broad leaved and grassy weeds *viz.*, *Medicago denticulata* Willd., *Vicia sativa* L., *Cynodon dactylon* L., *Cyperus rotundus* L. (Table1).

Total weeds density (m²)

Weed control practices caused identical influence in reducing the density of total mean weed density. The statistical analysis of the analyzed data during the year perusal data (Table 2) showed that lower weed density was found under hand weeding (30 DAS) 7.53 over weedy check 22.71 which was significantly superior over of the weed control practices. The all weed control treatment was also reducing the total weed density over weedy treatments. The Pendimethalin (1000 g ha⁻¹) 9.48, Oxyflorfen (100 g ha⁻¹) 10.59, Atrazine (1000 g ha⁻¹) 10.76 was also found more effective to reducing the total weed density under *Jatropha* based Agroforestry. Similar results were proposed by Virender. P. Singh *et al.*, (2016) [20].

Weed dry weight

The weed control practices have marked variation on the total dry weight of the weeds. The perusal data (Table 2) showed that the minimum dry weight of weeds was found under hand weeding (30 DAS) 5.42 q ha⁻¹ over weedy check (control) 16.84 q ha⁻¹. All the weed control treatments were also reduced the total dry weight of weeds over weedy check. The hand weeding (30DAS) 5.42 q ha⁻¹ proved more effective. Amongst the different weed control practices Pendimethalin (1000 g ha⁻¹) 7.79 q ha⁻¹, Atrazine (1000 g ha⁻¹) 9.57 q ha⁻¹, Oxyflorfen (100 g ha⁻¹) 9.65 q ha⁻¹, Metribuzin (150 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹) 9.88 q ha⁻¹ and Pendimethalin (500 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹) 10.73 q ha⁻¹ were effective in reducing weed dry weight as compared to weedy check (control) 16.84 q ha⁻¹. The findings are in conformity with those reported by Vyas and Jain (2003) [21], Kachhadia *et al.*

(2009) [8], Upadhyay *et al.* (2012) [18], Goud *et al.* (2013) [7] and Rajib *et al.* (2014) [16].

Weed Control Efficiency

The result revealed that the highest weed control efficiency (Table 2) was found under hand weeding (30DAS) 89.75%, Amongst the different weed control practices Pendimethalin (1000 g ha⁻¹) 78.50%, Atrazine (1000 g ha⁻¹) 67.67%, Oxyflorfen (100 g ha⁻¹) 66.83%, Metribuzin (150 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹) 65.41%, were effective in controlling weeds over weedy under chickpea – Jatropha based Agroforestry system. Md. Nasimul Bari (2010) [11] had also recorded the highest weed control efficiency.

Weed index

The results revealed that the amongst the different weed control treatments (Table 2), the maximum losses caused by weeds was in weedy check (control) 51.23 % where weeds were allowed to grow with chickpea crop under Jatropha tree during entire season. The loss of grain yield was significantly reduced where weeds were control by Pendimethalin (1000 g ha⁻¹) 11.16 %, Metribuzin (150 g ha⁻¹) fb Oxyflorfen (50 g ha⁻¹) 11.19 %, Atrazine (500 g ha⁻¹) fb Metribuzin (150 g ha⁻¹) 23.34 %, Oxyflorfen (100 g ha⁻¹) 24.24 %, Metribuzin (300 g ha⁻¹) 24.68 %, Imazathaper (450 g ha⁻¹) fb Atrazine (500 g ha⁻¹) 30.00 %, Pendimethalin (500 g ha⁻¹) fb Imazathaper (450 g ha⁻¹) 31.17 %, Atrazine (1000 g ha⁻¹) 32.08 %, Imazathaper (900 g ha⁻¹) 36.70 %.

Seed yield

The result revealed that the significantly higher grain yield (Table 3) was found under hand weeding (30DAS) 14.33 q ha⁻¹ which was significantly superior over weedy check (control) 6.41 q ha⁻¹. Among herbicidal treatments higher seed yield was found under Pendimethalin (1000 g ha⁻¹) 12.54q ha⁻¹

¹ followed by Oxyflorfen (100 g ha⁻¹) 11.00 q ha⁻¹. These findings are in close conformity with those reported by Vyas and Jain (2003) [21], Kachhadia *et al.* (2009) [8], Upadhyay *et al.* (2012) [18], Mishra *et al.* (2013) [12], Rajib *et al.* (2014) [16] and Mamta *et al.* (2016) [10].

Stover yield

The significantly higher stover yield (Table 3) was found under hand weeding (30DAS) 41.69 q ha⁻¹ which was significantly superior over weedy check (control) 28.13 q ha⁻¹. Amongst the different herbicidal treatments the higher stover yield was found under Pendimethalin (1000 g ha⁻¹) 37.46 q ha⁻¹ followed by Oxyflorfen (100 g ha⁻¹) 37.43 q ha⁻¹ and Pendimethalin (500 g ha⁻¹) fb Imazathaper (450 g ha⁻¹) 35.04 q ha⁻¹. Similar findings were also reported by Patel *et al.* (2006) [14].

Crop Biomass

The significantly higher total crop biomass (Table 3) was found under hand weeding (30DAS) 56.02 q ha⁻¹ which was significantly superior over weedy check (control) 34.54 q ha⁻¹. Amongst the different herbicidal treatments higher crop biomass was found under Pendimethalin (1000 g ha⁻¹) 50.00 q ha⁻¹ followed by Oxyflorfen (100 g ha⁻¹) 48.43 q ha⁻¹ and Pendimethalin (500 g ha⁻¹) fb Imazathaper (450 g ha⁻¹) 45.09 q ha⁻¹.

Harvest index

The perusal data showed that higher harvest index (Table 3) was found under hand weeding (30DAS) 25.06 % which was significantly superior over weedy check (control) 18.74 %. Amongst the different herbicidal treatments higher harvest index was found under Pendimethalin (1000 g ha⁻¹) 24.99 % followed by Atrazine (500 g ha⁻¹) fb Metribuzin (150 g ha⁻¹) 24.97% and Metribuzin (300 g ha⁻¹) 24.01 %.

Table 1: Floristic composition of weeds

Botanical Name	Common Name	Family	Habit and characteristics
<i>Medicago denticulata</i> Willd.	Rough medik	Fabaceae	An annual decumbent herb, Glabrous or pubescent
<i>Vicia sativa</i> L.	Common vetch	Fabaceae	An annual herb, Decumbent-ascending
<i>Cynodon dactylon</i> L.	Bermuda grass	Poaceae	Perennial grass
<i>Cyperus rotundus</i> L.	Purple nutsedge	Cyperaceae	A perennial sedge, Hard, fragrant, globose-ovoid tubers

Table 2: Effect of different weed control practices on Weed density, weed dry weight and weed control efficiency of total weeds under Jatropha based Agroforestry

Treatment (Pre-emergence)	Weed Density (m ⁻²)	Weed Dry Weight (q ha ⁻¹)	WCE (%)	Weed Index (%)
T ₁ Pendimethalin (38.7% EC) 1000 g ha ⁻¹	9.48 (89.6)	7.79 (60.6)	78.50	11.16
T ₂ Imazathaper (10% SL) 900 g ha ⁻¹	11.27 (129.3)	11.16 (124.6)	56.13	36.70
T ₃ Atrazine (50% WP) 1000 g ha ⁻¹	10.76 (118.3)	9.57 (92.0)	67.67	32.08
T ₄ Metribuzin (70% WP) 300 g ha ⁻¹	12.70 (161.6)	11.37 (129.0)	54.42	24.68
T ₅ Oxyflorfen (23.5% EC) 100 g ha ⁻¹	10.59 (114.0)	9.65 (94.6)	66.83	24.24
T ₆ Pendimethalin 500 g ha ⁻¹ fb Imazathaper 450 g ha ⁻¹	10.94 (122.3)	10.97 (122.3)	57.10	31.17
T ₇ Pendimethalin 500 g ha ⁻¹ fb Oxyflorfen 50 g ha ⁻¹	11.31 (131.6)	10.73 (117.0)	58.85	34.37
T ₈ Metribuzin 150 g ha ⁻¹ fb Oxyflorfen 50 g ha ⁻¹	11.97 (145.6)	9.88 (98.3)	65.41	11.19
T ₉ Atrazine 500 g ha ⁻¹ fb Metribuzin 150 g ha ⁻¹	13.13 (172.6)	11.73 (137.3)	51.43	23.34
T ₁₀ Imazathaper 450 g ha ⁻¹ fb Atrazine 500 g ha ⁻¹	12.52 (156.6)	11.73 (137.3)	51.54	30.00
T ₁₁ Hand weeding (30 DAS)	7.53 (56.6)	5.42 (29.0)	89.75	00.00
T ₁₂ Weedy check (control)	22.71 (517.3)	16.84 (283.3)	00.00	51.23
S.Em±	0.73	0.55	3.96	6.80
CD (P=0.05)	2.12	1.61	11.57	19.83

Table 3: Effect of different weed control treatment on Seed yield (q ha⁻¹), Stover yield (q ha⁻¹), crop Biomass (q ha⁻¹) and Harvest index (%), of chickpea under Jatropha based Agroforestry

Treatments	Seed yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)	Crop biomass (q ha ⁻¹)	Harvest index (%)
T ₁ Pendimethalin (38.7% EC) 1000 g ha ⁻¹	12.54	37.46	50.00	24.99
T ₂ Imazathaper (10% SL) 900 g ha ⁻¹	8.44	28.50	36.94	23.26
T ₃ Atrazine (50% WP) 1000 g ha ⁻¹	9.70	31.41	41.11	23.41
T ₄ Metribuzin (70% WP) 300 g ha ⁻¹	10.63	33.63	44.26	24.01
T ₅ Oxyflorfen (23.5% EC) 100 g ha ⁻¹	11.00	37.43	48.43	22.04
T ₆ Pendimethalin 500 g ha ⁻¹ fb Imazathaper 450 g ha ⁻¹	10.06	35.04	45.09	22.02
T ₇ Pendimethalin 500 g ha ⁻¹ fb Oxyflorfen 50 g ha ⁻¹	8.33	31.95	40.28	21.01
T ₈ Metribuzin 150 g ha ⁻¹ fb Oxyflorfen 50 g ha ⁻¹	9.22	31.24	40.46	22.87
T ₉ Atrazine 500 g ha ⁻¹ fb Metribuzin 150 g ha ⁻¹	10.85	33.04	43.89	24.97
T ₁₀ Imazathaper 450 g ha ⁻¹ fb Atrazine 500 g ha ⁻¹	9.13	30.67	39.80	23.20
T ₁₁ Hand weeding (30 DAS)	14.33	41.69	56.02	25.06
T ₁₂ Weedy check (control)	6.41	28.13	34.54	18.74
SEm±	1.45	2.75	3.99	1.57
CD (P=0.05)	4.24	8.04	11.64	4.59

Note: DAS: Days after sowing, EC: Emulsifiable concentration, WP: Wettable powder, fb: followed by

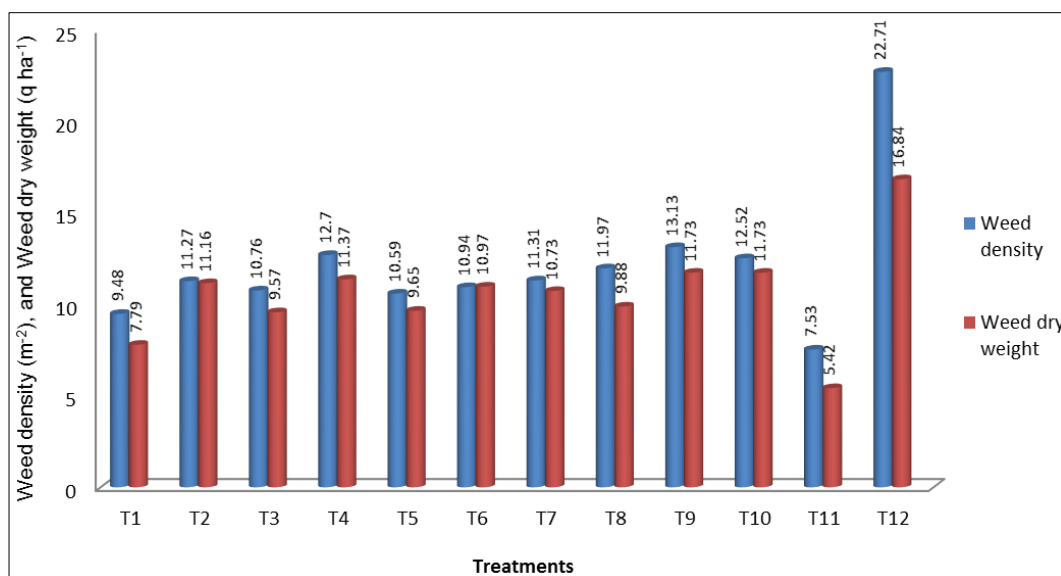


Fig 1: Effect of different weed control practices on Weed density and weed dry weight of total weeds under Jatropha based Agroforestry

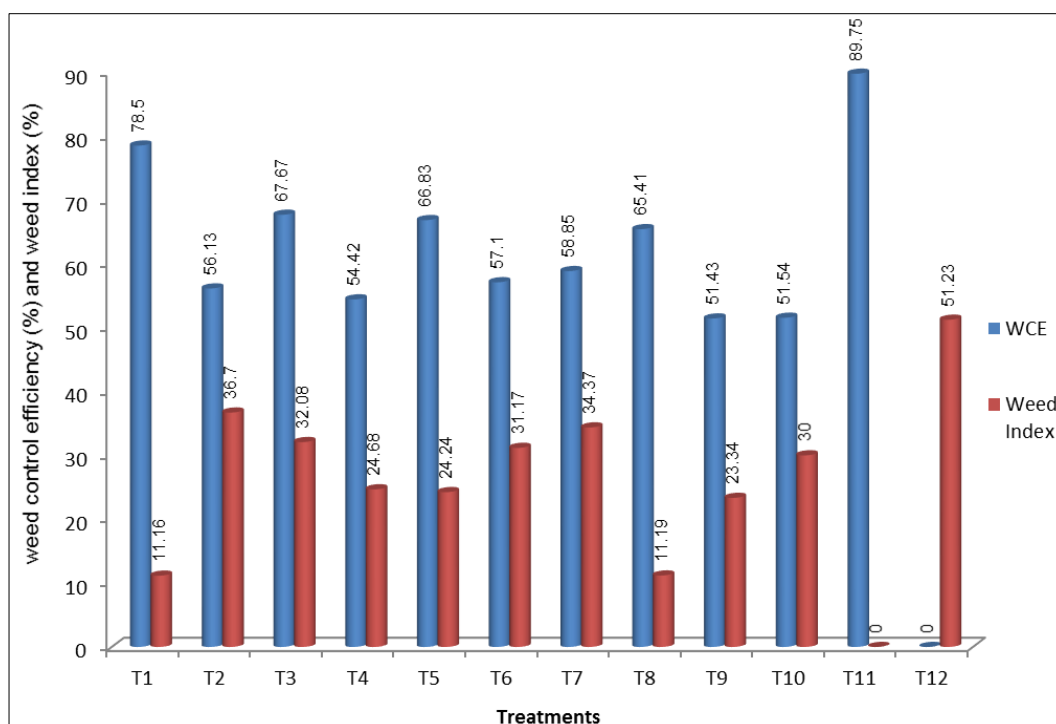


Fig 2: Effect of different weed control practices on weed control efficiency and weed index of total weeds under Jatropha based Agroforestry

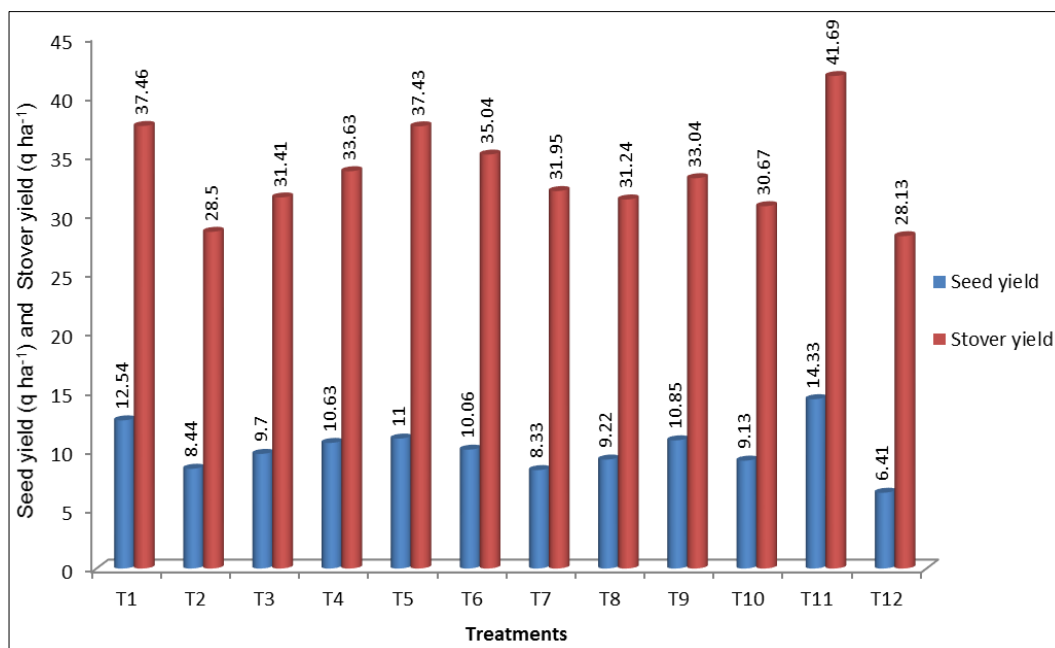


Fig 3: Effect of different weed control treatment on Seed yield (q ha⁻¹) and Stover yield (q ha⁻¹) of chickpea under Jatropa based Agroforestry

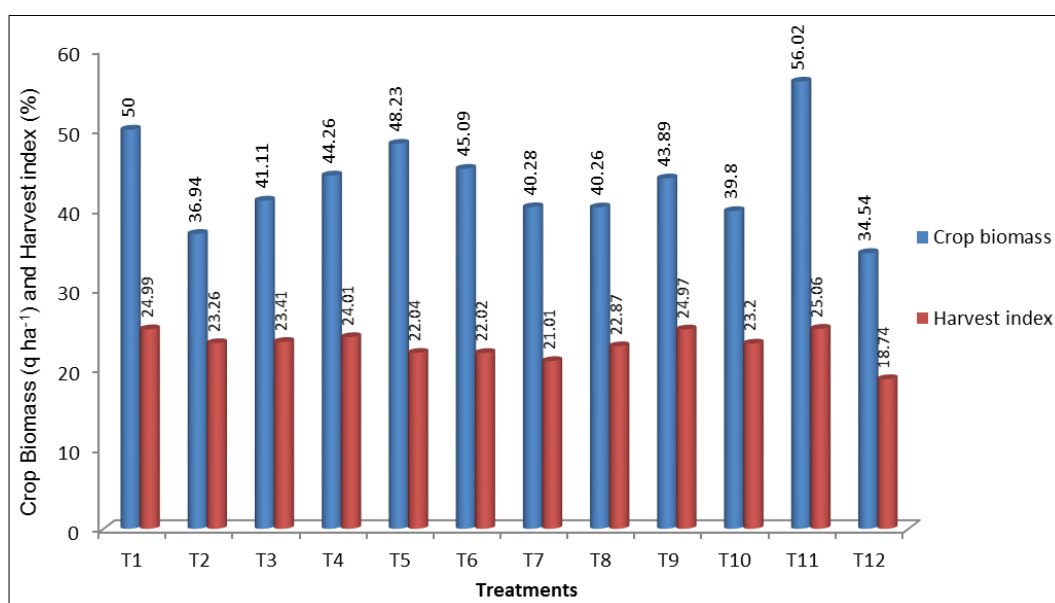


Fig 4: Effect of different weed control treatment on crop Biomass (q ha⁻¹) and Harvest index (%), of chickpea under Jatropa based Agroforestry

Conclusion

From the above going findings it may be concluded that hand weeding 30DAS, Pendimethalin (1000 g ha⁻¹) reduce weed density and dry weight of weeds. These treatments also increase yield components of gram significantly. Maximum weed control efficiency was Pendimethalin (1000 g ha⁻¹). Lowest weed index (%) was in Pendimethalin (1000 g ha⁻¹) and Metribuzin 150 g ha⁻¹ fb Oxyflorfen 50 g ha⁻¹. In maximum seed yield stover yield and harvest index were recorded in Pendimethalin (1000 g ha⁻¹) and Oxyflorfen (23.5% EC) 100 g ha⁻¹ as compared to other treatments.

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