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Research Paper

Floristic composition and weed dynamics in 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 and 2020-21 to find out the floristic composition and weed dynamics in 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}), Imazethapyr (900 g ha^{-1}), Atrazine (1000 g ha^{-1}), Metribuzin (300 g ha^{-1}), Oxyfluorfen (100 g ha^{-1}), Pendimethalin (500 g ha^{-1}) fb Imazethapyr (450 g ha^{-1}), Pendimethalin (500 g ha^{-1}) fb Oxyfluorfen (50 g ha^{-1}), Metribuzin (150 g ha^{-1}) fb Oxyfluorfen (50 g ha^{-1}), Atrazine (500 g ha^{-1}) fb Metribuzin (150 g ha^{-1}), Imazethapyr (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. The significantly lowest weed density was found in hand weeding 30DAS (T_{11}: 7.53 and 7.09 m^{-2}) it was at par with Pendimethalin 1000 g ha^{-1} (T_1: 9.48 and 8.59 m^{-2}) over weedy check (T_{12}: 22.71 and 19.47 m^{-2}). The lowest total weed dry weight was recorded in hand weeding 30DAS (T_{11}: 5.42 and 7.26 g m^{-2}) at par with Pendimethalin (T_1: 7.79 and 7.86 g m^{-2}) over weedy check recorded higher weed dry weight (T_{12}: 16.84 and 15.0 g m^{-2}). The highest weed control efficiency was found under hand weeding 30DAS (T_{11}: 89.75 and 74.40 %) followed by Pendimethalin 1000 g ha^{-1} (T_1: 78.50 and 72.54 %) over weedy check. Pre emergence herbicides and hand weeding can further enhance the weed suppressive effect of the crop under Jatropha based Agroforestry.
KEY WARDS: *weeds, weed density, weed dry weight, weed control efficiency, herbicides.*

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I. 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).

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). 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). 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). The critical period of crop-weed competition for chickpea is up to 40 days. One of the reasons for low productivity of chickpea is more weed infestation during early growth period of the crop. To obtain best weed control results, today there are various methods invented by different research workers. It is necessary to develop cheaper method of weed control, which is none other than herbicidal method. In this context, herbicides will have important role to play in Indian agriculture, as they are substitute for human labour. Weed not only deteriorates the pod quality but also increase the expenditure on tillage and other cultivation practices. The usual cultural methods of weed control practiced by farmers in chickpea are hand weeding and hoeing. These methods of weed control depend upon availability of labour and favorable weather conditions. However, weed flora at the time of critical growth stage of *Rabi* crops, increase crop weed competition and drastically reduce crop yield. To increase crop yield cultural methods may be used, but increase in wages and scarcity of labour amounts in rise in cost of cultivation and simultaneously causing more harm to crop due to late weeding. It also observed that there are certain weed which cannot be controlled properly either by hoeing or hand weeding in an advance stage of its growth and they again come up with profuse branching and suppressing crop growth and yield. Hence, traditional method of weeding and hoeing are effective to control weeds but not feasible under wet condition of field and has limitation due to labour shortage at critical period. In such cases, chemical method of weed control can be very effective in killing the weeds before their emergence as well as after emergence. The use of herbicides has assumed a great significance particularly in intensive agriculture due to their ability of providing quick, effective, selective and economic weed management in term of time, money and labour.

II. 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 floristic composition and weed dynamics in 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}), Imazethapyr (900 g ha^{-1}), Atrazine (1000 g ha^{-1}), Metribuzin (300 g ha^{-1}), Oxyfluorfen (100 g ha^{-1}), Pendimethalin (500 g ha^{-1}) fb Imazethapyr (450 g ha^{-1}), Pendimethalin (500 g ha^{-1}) fb Oxyfluorfen (50 g ha^{-1}), Metribuzin (150 g ha^{-1}) fb Oxyfluorfen (50 g ha^{-1}), Atrazine (500 g ha^{-1}) fb Metribuzin (150 g ha^{-1}), Imazethapyr (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 P_2O_5 ha^{-1}) and potassium (136 kg K_2O ha^{-1}) content respectively. The soil was found slightly alkaline (pH 7.7) in reaction. Weed population was counted with the help of quadrate (0.50 m X 0.50 m) thrown randomly at four places in each plot and converted in to m^2 area. The weed dry matter was recorded from the quadrates after cutting weeds from the ground level and then oven dried at 70^0C and converted to m^2. The data on weeds were subjected to square-root transformation before statistical analysis.

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).

$$WCE\ (\%) = \frac{WD_c - WD_t}{WD_c} \times 100$$

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 count were subjected to square root transformation √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).

III. 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 (m^2)

The effect of weed control practices on total weed density was apparent during both years at all the growth stages. The result revealed that statistical analysis of the analyzed data during the both year perusal data (Table 2 and Fig 1) showed that the various treatments effect on the weed density during both years. The significantly lowest weed density was found in hand weeding 30DAS (T_{11}: 7.53 and 7.09 m^{-2}) it was at par with Pendimethalin 1000 g ha^{-1} (T_1: 9.48 and 8.59 m^{-2}) over weedy check (T_{12}: 22.71 and 19.47 m^{-2}) which recorded maximum total weed density during both the year. Whereas, T_5- Oxyfluorfen (23.5% EC) 100 g ha^{-1}, T_4- Metribuzin 300 g ha^{-1}, T_6-Pendimethalin 500 g ha^{-1} fb Imazethapyr 450 g ha^{-1}, T_3- Atrazine 1000 g ha^{-1}, T_7- Pendimethalin 500 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1} , T_2- Imazethapyr 900 g ha^{-1} have similarly contributed for reducing total weed density at 30DAS, 60DAS and at harvest during both year (2019-20) and (2020-21). All weed management practices have also reduced the total weed density during the both years. Similar results were proposed by Virender. P. Singh *et al.*, (2016).

The perusal of statistical analysis pooled data analyzed during the subsequent year reported that lowest total weed density was found in hand weeding at 30DAS (T_{11}: 7.31 m^{-2}) which was at par with Pendimethalin 1000 g ha^{-1} (T_1: 9.04 m^{-2}) over weedy check at (T_{12}: 21.09 m^{-2}) having significantly highest weed density. Among all weed control treatment were also reduce the total weed density over weed control T_3- Atrazine (50% WP) 1000 g ha^{-1}, T_6- Pendimethalin 500 g ha^{-1} fb Imazethapyr 450 g ha^{-1} and T_7- Pendimethalin 500 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1} was also found more effective to reducing the total weed density at 30DAS, 60DAS and at harvest under Jatropha based Agroforestry.

Weed dry weight

The weed management practices caused marked influence on total weed dry weight during both the year. The perusal of data showed that (Table 2 and Fig 2) the lowest total weed dry weight was recorded in hand weeding 30DAS (T_{11}: 5.42 and 7.26 g m^{-2}) at par with Pendimethalin (T_1: 7.79 and 7.86 g m^{-2}) over weedy check recorded higher weed dry weight (T_{12}: 16.84 and 15.0 g m^{-2}). However T_3- Atrazine 1000 g ha^{-1}, T_5- Oxyfluorfen (23.5% EC) 100 g ha^{-1}, T_8- Metribuzin 150 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1}, T_6- Pendimethalin 500 g ha^{-1} fb Imazethapyr 450 g ha^{-1} , followed by T_2- Imazethapyr 900 g ha^{-1}, and found effective for reducing the total weed dry weight the T_{12}- weedy check during both year. The findings are in conformity with those reported by Vyas and Jain (2003), Kachhadia et al. (2009), Upadhyay et al. (2012), Goud et al. (2013) and Rajib et al. (2014).

The perusal do statistical analysis pooled data analyzed during the subsequent year reported that significantly lowest total weed dry weight were found under hand weeding 30 DAS (T_{11}: 6.34 g m^{-2}) at par with Pendimethalin (T_1: 7.82 g m^{-2}) over weedy check (T_{12}- 15.92 g m^{-2}) and rest of the weed control treatments. However T_3- Atrazine 1000 g ha^{-1}, T_5- Oxyfluorfen 100 g ha^{-1}, T_8- Metribuzin 150 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1}, followed by T_2- Imazethapyr 900 g ha^{-1}, and found effective for reducing the total weed dry weight the T_{12}- weedy check during both years.

Weed Control Efficiency

Weed control practices caused marked variation on weed control efficiency during both the year. The perusal of statistical data reported that (Table 2 Fig 3) highest weed control efficiency was found under hand weeding 30DAS (T_{11}: 89.75 and 74.40 %) followed by Pendimethalin 1000 g ha^{-1} (T_1: 78.50 and 72.54 %) over weedy check (T_{12}: 0.0 and 0.0 %). However, Atrazine 1000 g ha^{-1} (T_3: 67.67 and 64.39 %), Oxyfluorfen (23.5% EC) 100 g ha^{-1} (T_5: 66.83 and 64.54 %), Metribuzin 150 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1} (T_8: 65.41 and 64.68 %), also found effective weed control efficiency over weedy check. Md. Nasimul Bari (2010) had also recorded the highest weed control efficiency.

The perusal of statistical analysis of the pooled data analyzed during subsequent year reported that the highest weed control efficiency was found under hand weeding (T_{11}: 83.08 %) at par with Pendimethalin (T_1: 75.52 %). However Atrazine 1000 g ha^{-1} (T_3: 66.03 %), Metribuzin 150 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1} (T_8: 65.05 %), Oxyfluorfen (23.5% EC) 100 g ha^{-1} (T_5: 65.03 %), Pendimethalin 500 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1}

(T_7: 58.13 %), Imazethapyr 900 g ha^{-1} (T_2: 56.18 %) , Pendimethalin 500 g ha^{-1} fb Imazethapyr 450 g ha^{-1} (T_6: 54.89 %), also found effective weed control efficiency over weedy check.

Table1. Floristic composition of weeds

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

Table2. Effect of weed management practices on total weed density (m^{-2}), weed dry weight and weed control efficiency of total weeds at different intervals under gram - *Jatropha curcus* based Agroforestry system.

Treatment		Total weed density (m^{-2})			Weed dry weight (g m^{-2})			Weed control efficiency (%)		
		2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T_1	Pendimethalin (38.7% EC) 1000 g ha^{-1}	9.48 (89.6)	8.59 (73.6)	9.04 (81.6)	7.79 (60.6)	7.86 (81.0)	7.82 (92.3)	78.50	72.54	75.52
T_2	Imazethapyr (10% SL) 900 g ha^{-1}	11.27 (129.3)	10.41 (108.6)	10.84 (119.0)	11.16 (124.6)	9.92 (98.3)	10.54 (111.5)	56.13	56.22	56.18
T_3	Atrazine (50% WP) 1000 g ha^{-1}	10.76 (118.3)	10.06 (102.0)	10.41 (110.1)	9.57 (92.0)	8.92 (80.0)	9.25 (76.16)	67.67	64.39	66.03
T_4	Metribuzin (70% WP) 300 g ha^{-1}	12.70 (161.6)	11.41 (132.0)	12.06 (146.8)	11.37 (129.0)	10.0 (100.3)	10.70 (114.6)	54.42	55.33	54.88
T_5	Oxyfluorfen (23.5% EC) 100 g ha^{-1}	10.59 (114.0)	10.73 (115.3)	10.66 (114.6)	9.65 (94.6)	8.91 (79.6)	9.28 (87.16)	66.83	64.54	65.68
T_6	Pendimethalin 500 g ha^{-1} fb Imazethapyr 450 g ha^{-1}	10.94 (122.3)	10.96 (121.3)	10.95 (121.8)	10.97 (122.3)	10.18 (106.3)	10.58 (114.3)	57.10	52.67	54.89
T_7	Pendimethalin 500 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1}	11.31 (131.6)	10.18 (104.6)	10.75 (118.1)	10.73 (117.0)	9.73 (95.6)	10.23 (106.0)	58.85	57.40	58.13
T_8	Metribuzin 150 g ha^{-1} fb Oxyfluorfen 50 g ha^{-1}	11.97 (145.6)	11.63 (135.0)	11.80 (140.3)	9.88 (98.3)	8.87 (79.3)	9.37 (88.83)	65.41	64.68	65.05
T_9	Atrazine 500 g ha^{-1} fb Metribuzin 150 g ha^{-1}	13.13 (172.6)	12.40 (154.0)	12.77 (163.3)	11.73 (137.3)	10.37 (107.3)	11.05 (122.3)	51.43	52.22	51.83
T_{10}	Imazethapyr 450 g ha^{-1} fb Atrazine 500 g ha^{-1}	12.52 (156.6)	12.11 (147.0)	12.32 (151.8)	11.73 (137.3)	9.85 (96.6)	10.79 (117.0)	51.54	56.97	54.26
T_{11}	Hand weeding (30 DAS)	7.53 (56.6)	7.09 (50.0)	7.31 (53.3)	5.42 (29.0)	7.26 (53.0)	6.34 (41.0)	89.75	74.40	83.08
T_{12}	Weedy check (control)	22.71 (517.3)	19.47 (379.6)	21.09 (448.5)	16.84 (283.3)	15.0 (224.6)	15.92 (254.0)	00.0	00.0	00.0
SEm±		0.73	0.37	0.40	0.55	0.48	0.36	3.96	4.16	2.84
Treatment (T) CD (P=0.05)		2.12	1.09	1.15	1.61	1.40	1.02	11.57	12.15	8.06
Year (Y) CD=0.05		-	-	0.47	-	-	0.42	-	-	3.29
Interaction (Y x T) CD (P=0.05)		-	-	1.62	-	-	1.45	-	-	11.40

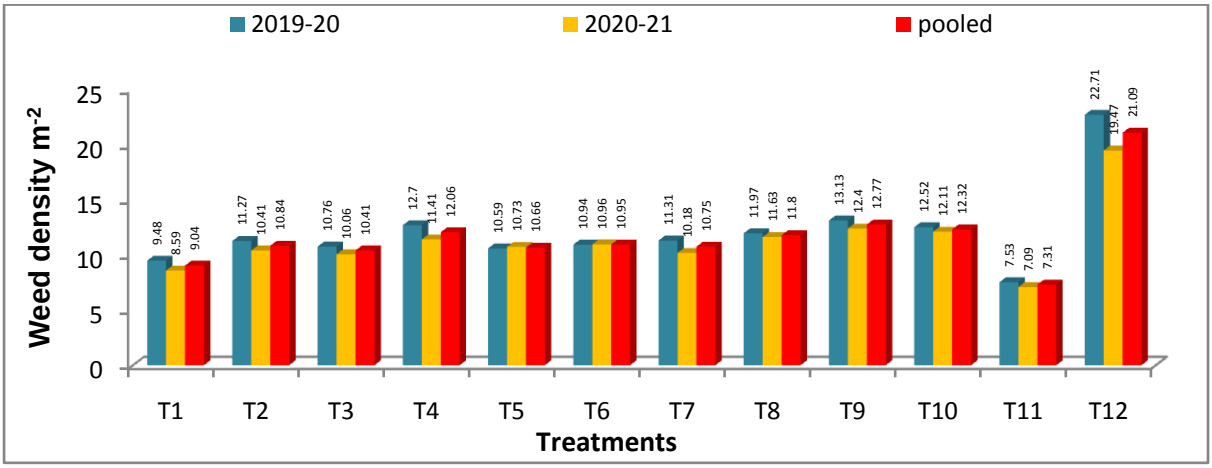

Fig1: Effect of different weed control practices on Weed density of total weeds under Jatropha based Agroforestry

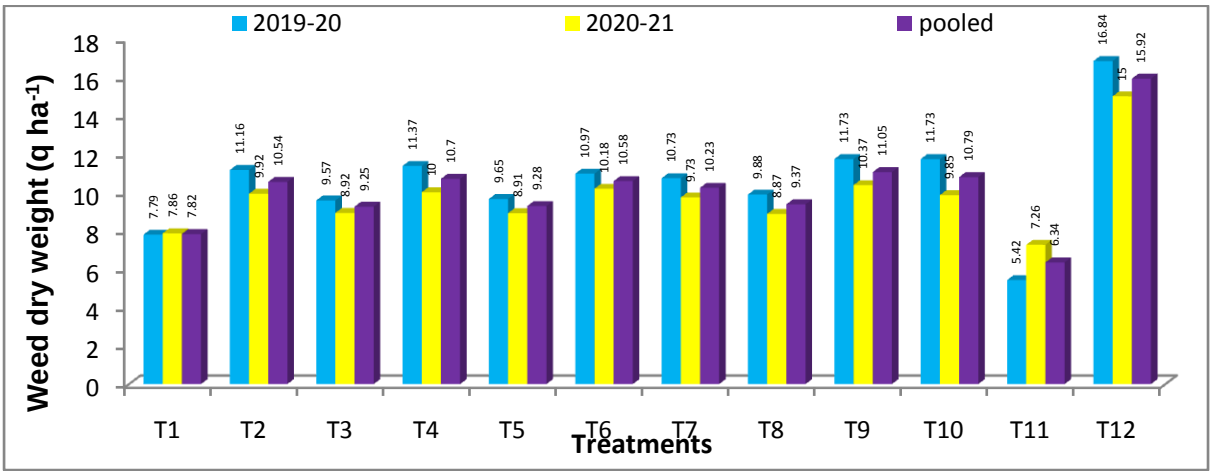

Fig2: Effect of different weed control practices on weed dry weight of total weeds under Jatropha based Agroforestry

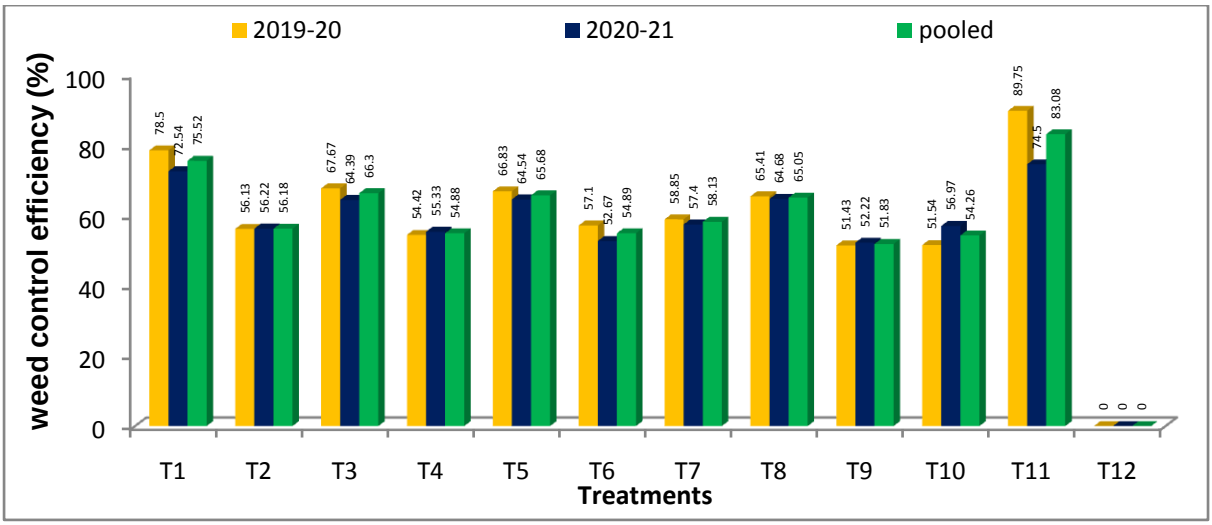

Fig3: Effect of different weed control practices on weed control efficiency of total weeds under Jatropha based Agroforestry

IV. 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}).

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