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Short Research Article

Effect of Various Weed Management Practices on Pigeon Pea (*Cajanus cajan* L. Millsp.)

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Abstract

A field experiment was conducted during the *kharif* season, 2011 to study how pigeon pea (*Cajanus cajan* L. Millsp.) respond to various weed management practices under foothills agro-climatic condition of Nagaland. Hand weeding at 20 and 40 DAS (T_9) resulted in the lowest weed density (No. m^{-2}), highest WCE (72.53%), lowest dry weight of weeds (15.33 g m^{-2}) at 30 DAS. At 60 and 90 DAS, lowest dry weight of weeds (15 g m^{-2} and 32.00 g m^{-2}) was noted with application of Imazethapyr @75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS+1 hand weeding on 50 DAS/ Intercultivation. Hand weeding twice (20 and 40 DAS) produced better growth attributes viz. plant height (cm), shoot dry weight (g), number of branches measured 30, 60, 90, 120 DAS and at harvest; yield attributes viz. pod weight $plant^{-1}$, number of seeds pod^{-1}, 100 seed weight (g), seed yield (kg ha^{-1}). Highest net return (₹ 30669.85 ha^{-1}) and benefit:cost ratio (1.51) noticed when weeds were removed by hand weeding at 20 and 40 DAS (T_9) compared to all the treatments under study.

1. Introduction

Pigeon pea (*Cajanus cajan* L. Millsp.) commonly known as *arhar* or redgram or *tur* is one of the important pulse crop ranking 5th among the edible legumes of the world. After gram, *arhar* is the 2nd most important pulse crop in India and stands 1st in pulse production (15 mt), accounting to 25.1% of share in world's production (Anonymous, 2008). During 2009-10, India produced 2.46 mt, averaging 711 kg ha^{-1} yields (Anonymous, 2012). Nagaland's average yield of *arhar* during the year 2008-09 was 703 kg ha^{-1} (Anonymous, 2012).

It is a rich source of protein (dal contains as much as 22% protein) and supplies a major share of the protein requirement of vegetarian population of India. Seeds of *arhar* are also rich in iron, iodine, essential amino acids like lycine, tyrocene, cystine and arginine.

Pigeon pea improves the physical structure of soil thereby enhancing water infiltration for subsequent crops, and plays a crucial role in sustaining agriculture in rainfed, semi-arid farming systems (Arunachalam et al., 1995). Pigeon pea, being a widely spaced crop with slow initial growth, is often intercropped with short duration legume for bonus production and also to keep the weeds under check. When farmers do not get their field weeded at appropriate time due to manpower shortage or heavy rains, weeds become a nuisance causing 32-65% yield loss (Vaishya and Khan, 1989; Kolar et al., 1985). For a long time, herbicides were mainly seen as a substitute to cultural and mechanical methods of weed control. Control of weeds has seriously deteriorated due to drastic and wide spread emergence of weeds that are resistant to currently used herbicides. Social and environmental concern as well as desire to improve the weed control efficiency has led to increase emphasis on integrating different weed management methods (Mechanical, cultural, chemical and biological). Knowledge about effective management practices for weed control in pigeon pea under foothills agro-climatic condition of Nagaland is meager. Therefore, keeping all the above points in mind, the present investigation was conducted.

2. Materials and Methods

The experiment was conducted during the *kharif* season of 2011 in experimental farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus, situated at 25°45′43″N latitude and 93° 53′04″ E longitude at an elevation of 310 meters above mean sea level. The soil of the experimental field was categorized as sandy loam, acidic in reaction (pH 4.7), low in N, medium in P and K status. WRG 27 pigeon pea variety was used in the

investigation. The experiment was laid out in a randomized block design (RBD) comprising of nine treatments replicated thrice. The treatments comprised of T_1-Weedy check, T_2-Pendimethalin @ 0.75 kg a.i. ha^{-1}+1 hand weeding on 50 DAS/Intercultivation, T_3-EPOE Imazethapyr @ 75 g a.i. ha^{-1} at 10-15 DAS+1Hand weeding on 50 DAS/Intercultivation, T_4- Imazethapyr @ 75 g a.i. ha^{-1} at 10 DAS+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS, T_5- Tank mix Imazethapyr @ 75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS, T_6 - Imazethapyr @ 75 g a.i. ha^{-1}+Quizalofop ethyl @ 50g a.i. ha^{-1} on 15 DAS+1 Hand weeding on 50 DAS/Intercultivation, T_7-Tank mix Imazethapyr @ 75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on15 DAS+1 Hand weeding on 50 DAS/Intercultivation, T_8-Pendimethalin @ 0.75 kg a.i. ha^{-1}+Imazethapyr @ 75 g a.i. ha^{-1} at 10-15 days after emergence of weeds, T_9-Hand weeding at 20 and 40 DAS (Days after sowing). Pigeon pea variety WRG 27 was sown in furrows maintaining 60 cm row-row and 20 cm plant-plant distance on 22nd June 2011 and harvested on 7th February 2012. Recommended dose of N @ 20 kg ha^{-1}, P_2O_5 @ 40 kg ha^{-1} were applied as basal application in the form of urea and DAP (Di-ammonium phosphate) respectively. Rhizobium bio-fertilizer @ 200 g 10 kg^{-1} of seeds was used as seed treatment. Five plants were selected randomly from each plot and their dry weight was taken after drying in oven at 70°C for 72 hours or till constant weight was obtained. Observations on growth attributing characters viz. plant height (cm), no. of branches plant^{-1}, yield attributing characters viz. pods plant^{-1}, no. of seeds pod^{-1}, 100 seed weight (g) and seed yield (q ha^{-1}); economics viz. cost of cultivation(₹ ha^{-1}), net returns (₹ ha^{-1}), benefit:cost ratio, weed parameters viz. weed flora, weed density (no. m^{-2}), weed dry weight (g m^{-2}) and weed control efficiency (%) were recorded. The collected data were processed, classified, tabulated and analyzed statistically by applying the techniques of analysis of variance (ANOVA) and the significance tested by F test (Cochran and Cox, 1957).

3. Results and Discussion

3.1. Effect on weeds

The dominant weed species in the experimental field were *Cynadon dactylon* (L.) Pers, *Digitaria sanguinalis* L., *Eleusine indica* L., *Cyperus rotundus* L., *Cyperus iria* L., *Ageratum conozoides* L., *Borreria hispita* L. and *Mimosa pudica* L.

All the weed control methods decreased the density and dry matter accumulation of weeds significantly over unweeded check. The lowest weed density (no. m^{-2}) 30, 60 and 90 DAS (Table 1) was observed by the application of T_9 (Hand weeding at 20 and 40 DAS). Before the weeds could establish itself well in the field, they were uprooted at 20 DAS and again at 40 DAS thereby giving no opportunity to the weeds for flowering and seed setting. This may be the possible reason for low weed density observed by the application of T_9 (Hand weeding at 20 and 40 DAS) Similar observations were documented by Chandel and Saxena (2001) and Pandya et al. (2004). At 30 DAS (Table 1), lowest dry weight (g) was noted with the application of T_9 (Hand weeding at 20 and 40 DAS) which may

Table 1: Effect of treatments of weed management on weed density, weed dry weight (g m^{-2}) and weed control efficiency (%)

Treatments	30 DAS		60 DAS		90 DAS		
	Weed density (no. m^{-2})	Weed dry weight (g m^{-2})	Weed density (no. m^{-2})	Weed dry weight (g m^{-2})	Weed density (no. m^{-2})	Weed dry weight (g m^{-2})	WCE (%)
T_1	105.33	86.00	104.33	100.67	65.67	116.67	0
T_2	84.00	80.00	40.67	17.67	43.67	39.67	51.81
T_3	43.33	38.67	34.67	16.03	32.33	33.67	70.08
T_4	29.00	28.00	50.00	51.67	45.67	75.33	50.51
T_5	53.00	53.67	92.67	79.67	42.67	97.67	24.91
T_6	40.00	35.67	34.33	15.00	27.33	32.00	72.06
T_7	64.00	53.33	53.00	19.33	55.86	44.33	60.23
T_8	53.00	53.00	44.00	68.81	49.33	81.33	33.44
T_9	9.67	15.33	11.33	29.33	23.00	41.33	72.53
SEm±	2.88	1.87	3.32	3.39	2.26	4.85	
CD (*p*=0.05)	8.64	5.60	9.94	10.15	6.78	14.55	

T_1 : Weedy check; T_2: Pendimethalin @ 0.75 kg a.i. ha^{-1}+1 hand weeding (HW) on 50 DAS/Intercultivation; T_3 : EPOE Imazethapyr @ 75 g a.i. ha^{-1} at 10-15 DAS+1 HW on 50 DAS/Intercultivation; T_4: Imazethapyr @ 75 g a.i. ha^{-1} at 10 DAS+Quizalofop ethyl @50 g a.i. ha^{-1} on 15 DAS; T_5: Tank mix Imazethapyr @75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS; T_6: Imazethapyr @75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS+1 HW on 50 DAS/Intercultivation; T_7: Tank mix Imazethapyr @75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS+1 HW on 50 DAS/Intercultivation; T_8: Pendimethalin @ 0.75 kg a.i. ha^{-1}+Imazethapyr @ 75 g a.i. ha^{-1} at 10-15 days after emergence of weeds; T_9: Hand weeding at 20 and 40 DAS DAS: Days after sowing; WCE: Weed control effeciency

be due to the presence of lower population of weeds because of one hand weeding operation performed at 20 DAS. At 60 and 90 DAS (Table 1), the lowest dry weight (g m^{-2}) of weeds was recorded with the application of T_6 (Imazethapyr @75g a.i. ha^{-1}+Quizalofop ethyl @50 g a.i. ha^{-1} on 15 DAS+1 Hand weeding on 50 DAS/Intercultivation). This may be attributed to one hand weeding performed at 50 DAS that reduced the dry weight (g m^{-2}) of weeds. The highest WCE (%) (Table 1) was observed in T_9 (Hand weeding at 20 and 40 DAS) followed by T_6 (Imazethapyr @ 75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS+1 Hand weeding on 50 DAS/Intercultivation) and T_3 (EPOE Imazethapyr @ 75 g a.i. ha^{-1} at 10-15 DAS+1 Hand weeding on 50 DAS/Intercultivation).

3.2. Effect on crop

3.2.1. Growth attributes

The highest plant height (cm) at 30, 60, 90 and 120 DAS (Table 2) was observed by the application of T_9 (Hand weeding at 20 DAS and 40 DAS). This may be due better suppression of weeds leading to lesser crop-weed competition for growth factors which ultimately created conducive environment for the pigeon pea plants to grow and reproduce luxuriantly. Similar finding was observed by Vivek et al. (2003) who reported that pigeon pea's height was severely hampered by the presence of weeds. The highest shoot dry weight (g), highest number of branches 30, 60, 90, 120 DAS and at harvest was observed in T_9 (Hand weeding at 20 DAS and 40 DAS).

3.2.2. Yield attributes and yield

There were no significant differences in 100 seed weight (g) and number of seeds pod^{-1} (Table 3) due to the effect of different weed management practices. The highest number of pods $plant^{-1}$ (Table 3) was observed with the application of T_9 (Hand weeding at 20 and 40 DAS). T_9 brought about distinct improvement in growth attributes which may have resulted in formation of more number of pods/plant. Yadav and Singh (2009) also published similar findings in pigeon pea.

Highest seed yield (14.57 q ha^{-1}) was recorded with the application of T_9 (Hand weeding at 20 and 40 DAS) followed by the application of T6 (Imazethapyr @ 75g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS+1 Hand weeding on 50 DAS/ Intercultivation) that produced 13.12 q ha^{-1} of pigeon pea seeds (Table 3). Higher seed yield under T_9 may be due to better growth of pigeon pea plants thus producing improved yield attributing characters compared to other treatments under study. Treatments T_3 (EPOE Imazethapyr @ 75 g a.i. ha-1 at 10-15 DAS+1Hand weeding on 50 DAS/Intercultivation) and T_6 (Imazethapyr @75 g a.i. ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS+1 Hand weeding on 50 DAS/Intercultivation) were found to be statistically at par with respect to their effect in seed production (13.05 q ha^{-1} and 13.12 q ha^{-1} respectively). Lowest seed yield of 4.37q ha^{-1} (Table 3) was noticed in weedy check (T_1) followed by the application of T_5 (Tank mix Imazethapyr @ 75 g ai ha^{-1}+Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS) that yielded 6.52 q ha^{-1} seeds. Srivastava and Srivastava (2004) also reported similar findings that hand weeding at 20 and 40 DAS gave significantly higher yield attributes and seed yield (q ha^{-1}) in pigeon pea.

3.3. Economics

Hand weeding at 20 and 40 DAS (T_9) respectively produced the highest net return (₹ 30669.85 ha^{-1}). This is due to higher seed yield (14.57 q ha^{-1}) of pigeon pea which compensated the cost (₹ ha^{-1}) incurred in hand weeding twice at 20 and 40 DAS. Sinha et al. (1989) documented similar findings where hand weeding twice at 20 and 40 DAS respectively produced

Table 2: Effect of treatments of weed management on growth parameters

Treat-ments	30 DAS			60 DAS			90 DAS			120 DAS			At harvest		
	Plant height (cm)	Shoot dry weight (g)	No. of branches $plant^{-1}$	Plant height (cm)	Shoot dry weight (g)	No. of branches $plant^{-1}$	Plant height (cm)	Shoot dry weight (g)	No. of branches $plant^{-1}$	Plant height (cm)	Shoot dry weight (g)	No. of branches $plant^{-1}$	Plant height (cm)	Shoot dry weight (g)	No. of branches $plant^{-1}$
T_1	38.40	7.33	3.33	48.23	12.67	7.20	85.00	13.17	16.30	107.80	26.40	32.00	124.33	53.67	63.4
T_2	54.03	10.00	6.99	80.87	21.07	12.07	133.97	35.33	17.97	178.92	54.67	68.6	179.27	73.24	79.6
T_3	49.53	10.33	8.07	93.07	27.56	13.80	150.97	47.33	21.63	184.73	54.53	86.75	194.47	68.99	124.4
T_4	58.49	11.67	7.47	90.80	21.35	10.93	138.47	44.40	20.53	176.17	46.00	76.00	188.57	83.67	109.8
T_5	43.04	12.00	6.20	79.40	16.97	8.77	119.00	36.00	16.80	159.47	39.33	40.99	188.87	91.21	64.4
T_6	60.54	8.67	7.87	104.10	20.67	13.33	153.47	28.27	22.14	170.43	60.00	96.00	195.53	87.79	135.75
T_7	55.43	13.00	6.40	86.60	28.27	11.07	140.07	32.00	19.38	167.67	58.67	71.5	183.67	105.70	101.8
T_8	55.19	10.44	6.70	93.10	30.40	11.47	143.90	42.00	18.28	182.53	69.33	70.5	191.47	83.33	87.00
T_9	63.22	13.00	10.60		33.33	16.20	176.33	64.27	26.87	215.07	91.33	155.83	231.60	127.67	166.0
SEm±	3.12	0.94	0.78	5.14	1.46	1.49	7.88	2.05	1.90	10.94	3.09	6.09	17.35	6.21	7.63
CD (p=0.05)	9.36	2.82	2.34	15.42	4.38	4.48	23.62	6.15	5.69	32.81	9.26	18.27	NS	18.63	22.89

Table 3: Effect of treatments of weed management on yield contributing characters and seed yield (q ha^{-1}) and economics

Treatment	No. of plant^{-1}	No. of seeds pod^{-1}	100 seed weight (g)	Seed yield (q ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1	50.67	3.44	11.33	4.37	14325.15	969.85	0.07
T_2	83.53	3.66	11.77	7.55	20425.15	5999.85	0.29
T_3	136.28	4.00	12.22	13.05	19107.15	26309.85	1.38
T_4	116.67	3.87	12.22	12.94	18357.15	26674.85	1.45
T_5	69.31	3.55	11.77	6.52	17607.15	4954.85	0.28
T_6	141.20	4.00	12.22	13.12	21357.15	24304.85	1.14
T_7	100.47	3.78	12.00	8.97	20607.15	10529.85	0.51
T_8	97.73	3.66	11.99	8.32	19207.15	9654.85	0.50
T_9	175.93	4.00	12.44	14.57	20325.15	30669.85	1.51
SEm±	5.93	0.20	0.38	0.62			
CD (*p*=0.05)	17.76	NS	NS	1.86			

1US$=₹ 49.12 during the time of harvesting

maximum average net return (₹ ha^{-1}) in pigeon pea. The highest benefit:cost ratio (1.51) was obtained by applying treatment T_9 (Table 3) indicating economical and cost effective weed management consequently increasing the seed yield (q ha^{-1}) over other treatments and resulting in higher monetary returns. Patil and Pandey (1996) published that hand weeding at 20 and 40 DAS resulted in significant decrease in weed population (No. m^{-2}), weed dry weight (g) and conspicuous increase in yield attributes and yield (q ha^{-1}) of pigeon pea resulting in higher net return (₹ ha^{-1}) and benefit: cost ratio. The lowest net return (₹ 969.85 ha^{-1}) and benefit: cost ratio (0.07) was observed in weedy check (T_1) (Table 3).

4. Conclusion

In terms of weed suppression, producing better growth and yield attributes, yield (q ha^{-1}) of pigeon pea, hand weeding at 20 and 40 DAS (T_9) established itself statistically superior than rest of the treatments under study. On analyzing the economics for different treatments, hand weeding at 20 and 40 DAS (T_9) again was found to be better compared to other treatments in terms of net return(₹ ha^{-1}) and benefit:cost ratio.

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