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Response of Integrated Weed Management Practices on Growth and Yield of Pigeonpea (*Cajanus cajan* (L.) Millsp.)

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ABSTRACT

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The field experiment was conducted during *kharif* (rainy) seasons of 2011 and 2012 at Regional Agricultural Research Station, Lam, Guntur, India in randomized block design with three replications to study the response of integrated weed management (IWM) practices on growth and yield of pigeonpea. The weed free treatment significantly decreased the weed density, dry weight of weeds and also increased in weed control efficiency compared with weedy check. Integration of one hand weeding/intercultivation at 50 DAS with application of imazathapyr @ 75 g *a.i./ha* at 10-15 DAS+quizalofop-ethyl @50g *a.i./ha* proved effective in reducing total weed density and dry weights of weeds and also increased in weed control efficiency compared with weedy check. The maximum values of growth parameters, yield attributes and yield (1934 kg/ha) were recorded under weed free situation but it was significantly superior over all other treatments. Among the IWM practices, application of imazethapyr @75g *a.i./ha* at 10-15 DAS+ quizalofop-ethyl @50g *a.i./ha* at 15 DAS followed by one hand weeding/intercultivation at 50 DAS resulted the maximum yield (1707 kg/ha) which was closely followed by application of Pendimethalin @ 0.75g *a.i./ha* PE+ Imazethapyr @ 60 g *a.i./ha* POE at 15 DAS (1509kg/ha) than weedy check (949 kg/ha). Beneficial effect due to above treatments on growth characters resulted in enhanced grain yields of pigeonpea.

Introduction

Pigeonpea (*Cajanus cajan* (L.) Millsp.) commonly known as red gram, *tur* or *arhar* is the fifth prominent legume crop in the world. India, Myanmar, Malawi, Kenya, Uganda and Tanzania are the major pigeonpea producing countries. It has been recognized as a valuable source of protein for the vegetarians in their daily diet. In India, pigeonpea is second most important pulse crop of India which has diversified

uses as food, feed, fodder and fuel, next to Chickpea producing 3.29 million tons annually from 3.88 million ha (Anon, 2013). The Indian sub continent alone contributes nearly 92 per cent of the total pigeonpea production in the world. Although India leads the world both in area and production of pigeonpea, its productivity is lower (697 kg/ha) than the world average (775 kg/ha) (FAO, 2013).

In India, pigeonpea is grown in *kharif* season. Due to rainy season, slow initial growth and sowing at wider spacing, severe infestation of weeds was observed in pigeonpea which results in low grain yield. Crop yield losses due to weeds have been estimated to range from 55 to 60% has been reported (Kandasamy, 1999). However, due to frequent rains it becomes difficult to hand weeding at proper time. Furthermore, non availability of labour for hand weeding is another problem. So it is very necessary to find out effective weed control techniques using herbicides. The predominant method of weed control by mechanical hoeing and manual weeding over extensive scale is found to decline because of shift of agricultural labourers to industries for better and assured wages. In pigeonpea, initial six-seven weeks period (42-49 days) is the critical period of crop-weed competition. Therefore, weeds must be controlled during this period for realising higher grain yields. Pre-emergence application of herbicides may help in checking weed growth during this period. Pendimethalin, as pre-emergence herbicide, has been found effective in controlling weeds and improving pigeonpea yield (Reddy *et al.*, 2007).

However, it is effective only up to one month and thereafter weeds may pose a problem again. Therefore, the use of herbicides alone or in combination with other weed control techniques reduces the crop weed competition and the risk of weeds growing unchecked in period of adverse weather. The integrated weed management approach is advantageous because one technique rarely achieve complete long and effective control of all weeds during crop season. Integrated use of pendimethalin with hand weeding or ridging may help in achieving season long weed control. Integrated weed management provides

effective and efficient weed management in pigeonpea (Reddy *et al.*, 2007; Sukhadia *et al.*, 2000 and Tomar *et al.*, 2004) and cowpea (Madukwe *et al.*, 2012).

Sometimes, farmers miss the application of pre-emergence herbicide and later on find it very difficult to control weeds manually. Under such situations, post-emergence application of herbicides may help in alleviating weed problem. Some of the herbicides may be phytotoxic to pigeonpea at higher rate of application (Kandasamy, 1999 and Semidey, 2002) or to the succeeding crop (Bidlack *et al.*, 2006). Therefore, the present investigation was undertaken to provide appropriate options to farmers for effective weed management in *kharif* pigeonpea.

Materials and Methods

Field experiments was conducted during *kharif* (rainy) season 2011 and 2012 at RARS, Lam, Guntur, India to find out the response of integrated weed management practices on growth and yield of pigeonpea. The soil of the experimental site was clay loam in texture with soil pH was neutral in reaction (6.2) and an electrical conductivity of 0.22 dSm⁻¹. The soil organic carbon content was low (0.51%). The soil was low in available nitrogen (223 kg ha⁻¹), medium in available phosphorus (23.4 kg ha⁻¹) and available potassium (312 kg ha⁻¹). The total rainfall received during crop growth period was 1060.9 mm in 59 rainy days. Seeds of pigeonpea variety LRG-41 were sown on 14th July, 2013 by dibbling method. Recommended dose of fertilizers 20 kg N and 50 kg P₂O₅/ha was applied through urea and single super phosphate (SSP) before dibbling.

The details of the treatments T₁: weedy check T₂: Pendimethalin @ 0.75 kg/ha PE +

1 hand weeding at 50 DAS/Intercultivation; T₃: EPOE Imazethapyr @75 g a.i./ha at 10-15 DAS+ 1 hand weeding at 50 DAS/Intercultivation; T₄: Imazethapyr @ 75g a.i./ha at 10-15 DAS+ Quizalofop ethyl @ 50 g a.i./ha POE AT 15 das; T₅: Tank mix application of Imazethapyr @ 75 g a.i./ha + Quizalofop ethyl @ 50 g a.i./ha POE at 15 DAS; T₆: Imazethapyr @ 75 g a.i./ha + Quizalofop ethyl @ 50 g a.i./ha POE at 15 DAS +1 hand weeding at 50 DAS/Intercultivation; T₇: Tank mix application of Imazethapyr @ 75 g a.i./ha + Quizalofop ethyl @ 50 g a.i./ha POE at 15 DAS+ 1 hand weeding at 50 DAS/Intercultivation; T₈: Pendimethalin @ 0.75g a.i./ha PE+ Imazethapyr @ 60 g a.i./ha POE at 15 DAS and T₉: Weed free were tested in randomized block design (RBD). In case of weed free treatment, two hand weedings at 25 DAS and 50 DAS manually using hand operated small implements. In case of pendimethalin treatments, the weedicide was sprayed on the same day after sowing using knapsack sprayer fitted with flood jet nozzle and the spray fluid was 500 litres per hectare. In case of quizalofop ethyl and imazathapyr were sprayed as post-emergence application at 10-15 DAS with a spray volume of 500 litres per hectare. Spraying was done by manually operated Knapsack sprayer. Then hand weeding and intercultivation operations were carried out after weedicide application as per treatments. The crop was grown with standard packages of practices for the region.

Plant height at harvest was recorded for randomly selected five plants. The weed counts were recorded by using quadrant at 70 DAS and kept in hot air oven for recording dry weights. Grain yield data was recorded on whole plot basis and then converted in to kg ha⁻¹. Data on yield components viz., branches per plant, pods plant⁻¹ and test weight (100 grain) was also

recorded. All data were subjected to analysis of variance (ANOVA) as per standard procedures. Whenever 'F' ratio was found significant, critical difference (CD) value was calculated at p=0.05 to compare the treatment means.

Results and Discussion

Effect on Weeds

The predominant weeds found in the experimental plots were broad leaf weeds such as *Euphorbia hirta*, *Digera arvensis*, *Trianthema portulacastrum*, *Phyllanthus niruri*, *Boerhavia diffusa*, *Cleome viscosa*, *Parthenium hysterophorus*, grassy weeds such as *Cynodon doctylon*, *Eleusine aegyptiacum* and sedge *Cyperus rotundus*. The experimental findings regarding integrated weed management practices on growth, yield attributes, yield of pigeonpea under rainfed condition during *kharif* seasons and on weed growth is given in Table 1 and 2. It was observed that the maximum weed intensity and weed dry weight in weedy check were significantly more as compared to rest of the treatments in both the years of investigation. The lowest weed counts/intensity and weed dry weights were observed in weed free treatment. The dry matter of weeds in weedy check was the maximum because of higher weed intensity and its dominance in utilizing the sunlight, nutrients, moisture, CO₂ etc. These results are in close conformity with those of Dhonde *et al.*(2009) and Idupuganti *et al.*(2005).

Unweeded control plot, as expected, recorded the highest dry matter of weeds, which was reduced drastically by all other treatments (Table 1). Among the herbicide treatments, post-emergence application of imazathapyr @ 75 g a.i./ha + quizalofop-ethyl @ 50g a.i./ha followed by one hand weeding/intercultivation at 50 DAS(T₈)

resulted in excellent control of monocot and dicot weeds than without integration of hand weeding/intercultivation (T₄). The highest weed counts and dry matter were recorded in weedy check plot than that of remaining treatments. Higher weed control efficiency (WCE) and long lasting effects of imazethapyrin reducing weed dry matter might be due to broad spectrum activity of herbicides particularly on established plants of both narrow and broad leaf weeds and its greater efficiency to retard cell division of meristems as a result of which weeds dried rapidly. This integrated use of herbicide(s) followed by hand weeding/intercultivation (at 50 DAS) results effective weed control (Singh and Sekhon, 2013 and Venkata Rao *et al.*, 2015).

Data regarding weed control efficiency

(WCE) as influenced by various weed control treatments, revealed that at 70 DAS, the maximum WCE was due to weed free treatment *i.e.* 100 per cent which was superior to those observed in rest of the treatments. Imazathapyr @ 75 g *a.i./ha* POE at 10-15 DAS + Quizalofop-ethyl @ 50 g *a.i./ha* – POE at 15DAS in integration with one hand weeding/intercultivation at 50 DAS (T₆) resulted in the highest weed control efficiency (WCE) (82.8 %) followed by T₇ (tank mix application of Imazathapyr@75 *a.i./ha* at 10-15 DAS +quizalofop-ethyl @50g *a.i. /ha* at 10-15 DAS and in integration with one hand weeding/intercultivation at 50 DAS) (80.3%) and T₅ (tank mix application of Imazathapyr@75 *a.i./ha* at 10-15 DAS +quizalofop-ethyl @50g *a.i. /ha* at 10-15 DAS) (74.3%).

Table.1 Effect of integrated weed control practices on growth and weeds in Pigeonpea

Treatments	Plant ht.(cm) at harvest			Weed counts (No./m ²)			Weed dry wt. (g/m ²)			WCE (%)		
	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean
T ₁	140	183	162	237	178	208	57.0	63.7	60.4	-	-	-
T ₂	178	174	176	105	79	92	16.7	18.3	17.5	70.7	71.3	71.0
T ₃	174	183	179	132	99	116	15.0	17.3	16.2	73.7	72.8	73.3
T ₄	196	205	201	76	57	67	16.3	16.7	16.5	71.4	74.1	72.9
T ₅	165	184	175	95	71	83	14.7	18.0	16.4	74.2	74.3	74.3
T ₆	196	227	212	64	48	56	11.0	9.7	10.4	80.7	84.8	82.8
T ₇	163	201	182	104	78	91	12.0	11.7	11.9	78.9	81.6	80.3
T ₈	176	237	207	181	136	159	17.7	16.0	16.9	71.9	74.9	73.4
T ₉	193	225	209	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0
SEM _±	8.8	14.6	-	12.8	9.6	-	1.67	1.87	-	-	-	-
CD (5%)	26.3	NS	-	38	29	-	5.0	5.6	-	-	-	-

T₁- Weedy check, T₂- Pendimethalin @ 0.75kg/ha-PE+ one HW at 50DAS/Intercultivation, T₃- EPOEImazathapyr@75 g *a.i./ha* at 10-15 DAS+ one HW at 50DAS/Intercultivation, T₄- Imazathapyr@75g *a.i./ha* at 10-15 DAS+ Quizalofop-ethyl @ 50 g *a.i. /ha* – POE at 15DAS, T₅- Tank mix application of Imazathapyr@75 g *a.i./ha* + Quizalofop-ethyl @ 50 g *a.i./ha* – POE at 15DAS, T₆- Imazathapyr@75g *a.i./ha* at 10-15 DAS+ Quizalofop-ethyl @ 50 g *a.i. /ha* – POE at 15DAS+ one HW at 50DAS/Intercultivation, T₇- Tank mix application of Imazathapyr@75 g *a.i./ha* + Quizalofop-ethyl @ 50 g *a.i. /ha* – POE at 15DAS+ one HW at 50DAS/Intercultivation, T₈- Pendimethalin 0.75 kg/ha pre- + Imazathapyr @ 60g *a.i./ha* at 10-15 DAS, T₉-Weed free.

Table.2 Effect of integrated weed control practices on yield attributes and grain yield in Pigeonpea

Treatments	Branches plant ⁻¹			Pods plant ⁻¹			Test weight (g)			Grain Yield (kg/ha)		
	2011	2012	Mean	2011	2012	Mean	2011	2012	Mean	2011	2012	Pooled
T ₁	18.3	13.0	15.7	126	124	125	9.8	10.8	10.3	530	1367	949
T ₂	21.7	15.0	18.4	185	144	165	11.0	11.8	11.4	1000	1517	1259
T ₃	21.8	10.3	16.1	189	161	175	10.9	12.1	11.5	864	1533	1199
T ₄	23.1	14.0	18.6	188	171	180	10.9	12.2	11.6	1214	1583	1399
T ₅	19.9	15.3	17.6	172	132	152	10.6	12.3	11.5	1031	1690	1361
T ₆	23.6	16.7	20.2	224	262	243	11.9	12.6	12.3	1281	2133	1707
T ₇	19.5	16.7	18.1	134	197	166	10.1	10.7	10.4	997	1469	1233
T ₈	23.3	15.3	19.3	192	187	190	11.8	11.8	11.8	1065	1952	1509
T ₉	23.3	19.3	21.3	230	282	256	12.0	14.7	13.4	1387	2481	1934
SEM _±	1.0	1.3	-	12	17.6	-	0.5	0.7	-	58.7	91.6	66.9
CD (5%)	3.0	4.1	-	37	53	-	1.4	2.1	-	176	276	200

T₁- Weedy check, T₂- Pendimethalin @ 0.75kg/ha-PE+ one HW at 50DAS/Intercultivation, T₃- EPOEImazathapyr@75 g a.i./ha at 10-15 DAS+ one HW at 50DAS/Intercultivation, T₄- Imazathapyr@75g a.i./ha at 10-15 DAS+ Quizalofop-ethyl @ 50 g a.i. /ha – POE at 15DAS, T₅- Tank mix application of Imazathapyr@75 g a.i./ha + Quizalofop-ethyl @ 50 g a.i./ha – POE at 15DAS, T₆- Imazathapyr@75g a.i./ha at 10-15 DAS+ Quizalofop-ethyl @ 50 g a.i. /ha – POE at 15DAS+ one HW at 50DAS/Intercultivation, T₇- Tank mix application of Imazathapyr@75 g a.i./ha + Quizalofop-ethyl @ 50 g a.i. /ha – POE at 15DAS+ one HW at 50DAS/Intercultivation, T₈- Pendimethalin 0.75 kg/ha pre- + Imazathapyr @ 60g a.i./ha at 10-15 DAS, T₉-Weed free.

Integration of hand weeding /intercultivation at 50 DAS with Pendimethalin @1.0 kg/ha PE or EPOE Imazathapyr @ 75 g a.i./ha POE at 10-15 DAS (T₃) proved effective than without integration of hand weeding/intercultivation at 50 DAS. This might be due to the efficient control of dicot weeds by hand weeding and /interculturing along with application of herbicides. Similar results of high WCE in urdbean (Gupta *et al.*,2014), soybean (Sharma *et al.*,2014) and pigeonpea (Venkata Rao *et al.*, 2015) was reported from Jammu, Rajasthan and Lam (AP), respectively.

Effect on crop

The maximum plant height (212 cm) was recorded in treatment T₆ but it was closely followed by T₄ (201cm), T₈ (207 cm) and T₉ treatments (209 cm), however, all these IWM practices superior over weedy check

(162 cm). Similarly, the highest yield attributes, *viz.* more number of branches per plant (21.3), pods per plant (256) and test weight (13.4 g) were recorded in weed free treatment and these values higher than other cultural and herbicide treatments including weedy check. Data pertaining to pods plant⁻¹ and test weight revealed that weed free and herbicides alone or in combination of intercultivation/HW at 50 DAS had significant effect on both parameters. Among the herbicides alone or integration of intercultivation/hand weeding at 50DAS with herbicides, T₆ recorded the highest values of pods plant⁻¹ (243) and test weight (12.3g) followed by T₈ (190 and 11.8g, respectively) and T₄ (180 and 11.6 g, respectively).It can be stated from the above findings that, though pods plant⁻¹ and 100 seed weight are varietal characters but tremendous weed infestation caused stress to the crop plants with respect to nutrients,

moisture, sunlight, space and other various aspects related to physiological processes of crop plants and these enforced the crop to have less number of pods plant⁻¹ and test weight and this was highly evident in weedy check treatment (Meena *et al.*, 2010).

The maximum grain yield (1934 kg/ha) was obtained with weed free treatment which was significantly superior than weedy check (949 kg/ha) and remaining other treatments. The lower grain yields were recorded with treatment weedy check (949 kg/ha) due to appearance of weeds since beginning of crop emergence and resulted in great competition with crop plants for nutrients, moisture and sunlight. Similar grain yield losses due to weeds were reported in *kharif* pigeonpea (Meena *et al.*, 2010 and Venkata Rao *et al.*, 2015). However, amongst the set of IWM treatments, the maximum grain yield was recorded under IWM treatments *viz.*, integration of one hand weeding/intercultivation at 50DAS with imazathapyr @ 75 g *a.i./ha* + quizalofop ethyl @ 50 g *a.i./ha* as POE at 10-15 DAS (1707 kg/ha) which was closely followed by T₈ treatment (1509 kg/ha). Higher grain yields in these treatments may be due to effective weed control as reflected in lower weed dry matter, higher WCE, better plant growth and yield attributes (Table 2). With integration of one hand weeding/intercultivation at 50DAS with application of imazathapyr @ 75 g *a.i./ha* + quizalofop ethyl @ 50 g *a.i./ha* as POE at 10-15 DAS proved better than other treatments. It can be explained in the light of the facts that these treatments controlled the weeds effectively, might have made more nutrients available to crop and consequently encouraged higher concentration of nutrients and more yields. This variation in weed control could be due to infestation of various weed species and climatic conditions including rainfall distribution pattern. These findings are in concurrence with those of

(Idupuganti *et al.*, 2005; Sharma *et al.*, 2014; Murali *et al.*, 2013 and Venkata Rao *et al.*, 2015).

In conclusion, from this study, it can be concluded that weed control is a limited factor for realizing higher grain yields in pigeonpea. Apart from the weed free treatment, weeds can also be effectively and efficiently controlled with integration of imazathapyr @ 75 g *a.i./ha* + quizalofop ethyl @ 50 g *a.i./ha* as POE at 10-15 DAS followed by hand weeding/intercultivation at 50 DAS which ultimately results in higher grain yields of pigeonpea.

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