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Research article

EFFECT OF INTEGRATED WEED MANAGEMENT PRACTICES ON GROWTH AND YIELD OF PIGEONPEA (*CAJANUS CAJAN* (L.) MILLSP.)

P.Venkata Rao*, A.Subbarami Reddy and Y.Koteswara Rao

Regional Agricultural Research Station, Lam-522034, Guntur, AP, India
Corresponding Author E-mail: venkatraoptn@gmail.com

ABSTRACT: The field experiment was conducted during *kharif* (rainy) season of 2013 at Regional Agricultural Research Station, Lam, Guntur, India in randomized block design with three replications to study the effect of integrated weed management 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 pendimethalin @ 0.75 kg *a.i.*/ha PE or imazathapyr @ 100 g *a.i.*/ha POE or quizalofop ethyl @100 *a.i.*/ha POE or pendimethalin@0.75 kg *a.i.*/ha PE and imazathapyr @ 100 g *a.i.*/ha POE 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 components and grain yield (2647 kg/ha) were recorded under weed free situation which was closely followed by IWM treatments *viz*., integration of pendimethalin @ 0.75 kg *a.i.*/ha PE and imazathapyr @ 100 g *a.i.*/ha POE or pendimethalin@ 0.75 kg *a.i.*/ha PE or imazathapyr @ 100 g *a.i.*/ha POE or quizalofop ethyl @ 100 g *a.i.*/ha POE or pendimethalin @ 0.75 kg *a.i.*/ha PE and quizalofop ethyl @ 100 g *a.i.*/ha POE with one hand weeding/intercultivation at 50 DAS. Beneficial effect due to above treatments on growth characters resulted in enhanced grain yields of pigeonpea.
Key words: Pigeonpea, IWM, weeds, weed control efficiency, hand weeding.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] Commonly known as red gram, *tur* or *arhar* is the fifth prominent legume crop in the world. India, Myammar, 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 [1]. 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) [2].

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 [3]. 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 [4]. 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[4-6] and cowpea[7]. 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 [3,8] or to the succeeding crop[9]. 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 2013 at RARS, Lam, Guntur, India to find out the effect 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 P_2O_5/ha was applied through urea and single super phosphate (SSP) before dibbling.

The details of the treatments T_1: Pendimethalin @ 0.75 kg/ha PE + 1 hand weeding at 50 DAS; T_2: Imazethapyr @100 g *a.i.*/ha POE+ 1 hand weeding at 50 DAS; T_3: Quizalofop ethyl @ 100 g *a.i.*/ha POE+ 1 hand weeding at 50 DAS; T_4: Pendimethalin @ 0.75 kg/ha PE+ Imazethapyr @ 100 g *a.i.*/ha POE; T_5: Pendimethalin @ 0.75 kg/ha PE+ Imazethapyr @ 100 g *a.i.*/ha POE + one hand weeding at 50 DAS/Inter cultivation; T_6: Pendimethalin @ 0.75 kg/ha PE+ Quizalofop ethyl @ 100 g *a.i.*/ha POE; T_7: Pendimethalin @ 0.75 kg/ha PE+ Imazethapyr @ 100 g *a.i.*/ha POE+ one hand weeding at 50 DAS/Inter cultivation; T_8: Weed free and T_9: weedy check 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 spay fluid was 500 litres per hectare. In case of quizalofop ethyl @ 100 g/ha and imazathapyr @100 g/ha were sprayed as post-emergence application at 10-15 DAS with a spray volume of 500 litres per hectare. 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, seeds/pod 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

Weeds

The predominant weeds found in the experimental plots were broad leaf weeds such as *euphorbia hirta, digera arvensis, trianthima portulcastrum, phyllanthus niruri, boerhavia diffusa, cleome viscosa,* 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 *kharif* condition and on weed growth is given in table 1. It was observed that weed intensity (330/m^2) and weed dry weight (49.8g/m^2) in weedy check were significantly more as compared to rest of the treatments. The lowest weed counts/intensity and weed dry weights were observed in weed free treatment. The dry matter of weeds in weedy check was maximum because of higher weed intensity and its dominance in utilizing the sunlight, nutrients, moisture, CO_2 *etc*. These results are in close conformity with those reported by Dhonde *et al*.[10], Idapuganti *et al*. [11] and Sukhaidia *et al*. [5].

Application of pendimethalin PE controlled all the weed species except *cyperus rotundus.* Among the herbicide treatments pre-emergence application of pendimethalin and one hand weeding/intercultivation at 50 DAS resulted in excellent control of monocots and dicot weeds. Post- emergence application of either imazathapyr or quizalofop-ethyl followed by one hand weeding/intercultivation at 50DAS resulted in very good control of both dicot and monocots weeds, respectively. However, integration of one hand weeding/intercultivation (at 50 DAS) either with imazathapyr POE or quizalofop-ethyl POE proved more effective in reducing the weed density in comparison to other treatments. The highest weed counts and dry matter were recorded in weedy check plot than other treatments. Post-emergence application of Imazathapyr @100g *a.i.*/ha at 10-15 DAS followed by one hand weeding/intercultivation at 50 DAS reduced the weed intensity to the maximum extent which was followed by pendimethalin @ 0.75 kg *a.i.*/ha PE and application of imazathapyr @ 100 g *a.i.*/ha POE at 10-15 DAS with one hand weeding/intercultivation at 50 DAS. This integrated use of herbicide(s) followed by hand weeding (at 50 DAS) results effective weed control [6,8,11,12].

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 significantly superior to those observed in rest of the treatments. Imazathapyr @ 100 g *a.i.*/ha POE at 10-15 DAS and in integration with one hand weedingintercultivation at 50 DAS resulted in high weed control efficiency (WCE) (86.1%) followed by pendimethalin PE followed by imazathapyr POE with hand weeding/intercultivation at 50 DAS (83.9%). The other IWM treatments followed the trend: pendimethalin PE followed by imazathapyr POE with hand weeding/intercultivation at 50DAS (83.9%); pendimethalin PE followed by quizalofop ethyl POE (80.3%); pendimethalin PE followed by hand weeding/intercultivation at 50 DAS (77.5%); pendimethalin PE followed by quizalofop ethyl POE with hand weeding/intercultivation at 50 DAS (73.3%). This might be due to the efficient control of dicot weeds by hand weeding and interculturing or application of herbicides. Similar results of high WCE in urdbean and pigeonpea was reported by Gupta *et al*. [13] at Jammu and Sharma *et al*.[14] at Kota (Rajasthan), respectively.

Yield attributes and Yield

The maximum plant height (250.7 cm) was recorded in weed free treatment which was significantly superior over weedy check (190.7 cm) and integration of hand weeding/intercultivation at 50 DAS with pendimethalin PE or Imazathapyr POE or pendimethalin PE followed by quizalofop ethyl POE, but it was on a par with the treatments, *viz*., quizalofop ethyl POE followed by hand weeding/intercultivation, pendimethalin PE followed by imazathapyr POE, pendimethalin PE followed by imazathapyr POE with hand weeding/intercultivation at 50 DAS and pendimethalin PE followed by quizalofop ethyl POE with hand weeding/intercultivation at 50 DAS. Similarly, more number of branches per plant (26.3) were recorded in the same weed free treatment and it was significantly higher than weedy check (12) and rest of the treatments except pendimethalin PE followed by imazathapyr POE (23.5).

The weed free treatment also recorded the highest number of pods per plant (430), test weight (11.6 g) and grain yield (2647 kg/ha) than weedy check (206.7, 9.2 g and 1477 kg/ha, respectively). The lower grain yields were recorded with treatment weedy check plot (1477 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. However, amongst the set of IWM treatments, the maximum grain yield was recorded under IWM treatments *viz*., hand weeding/inercultivation at 50 DAS with pendimethalin @ 0.75 kg *a.i.*/ ha PE and imazathapyr @ 100 g *a.i.*/ha POE (2642 kg/ha) followed by integration of hand weeding/intercultivation at 50DAS with pendimethalin @ 0.75kg *a.i.*/ha PE (2564 kg/ha) or imazathapyr @ 100g *a.i.*/ha POE (2511 kg/ha) or pendimethalin PE and quizalofop ethyl POE (2406 kg/ha) or quizalofop ethyl @ 100 g a.i./ha POE (2344 kg/ha) and the differences between these five treatment combinations were statistically at par with each other as well as with weed free plot. 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 1).

Table 1: Growth and yield of Pigeonpea as influenced by different weed control treatments

Treatments	Weed counts ($No./m^2$)	Weed Dry wt. ($g/m2$)	WCE	Plant ht. at harvest (cm)	Branches/ plant	Pods/ plant	Seeds/ pod	100 seed weight (g)	Grain yield (kg/ha)
T_1) Pendimethalin 0.75 kg/ha PE + 1 HW/IC at 50 DAS	49	11.2	77.5	227.3	22.2	381.7	5.9	10.7	2564
T_2) Imazethapyr 100 g *a.i.*/ha (POE)+ 1HW/IC at 50 DAS	41	6.9	86.1	230.7	21.1	351.7	6.0	10.6	2511
T_3) Quizalofop ethyl 100 g *a.i.*/ha (POE)+ 1HW/IC at 50 DAS.	64	15.8	68.3	235.3	22.8	325.7	6.1	11.0	2344
T_4) Pendimethalin 0.75 kg/ha PE+ Imazethapyr100g *a.i.*/ha (POE).	77	15.7	68.5	247.3	23.5	370.0	6.1	11.2	2319
T_5) Pendimethalin 0.75 kg/ha PE+ Imazethapyr 100 g *a.i.*/ha (POE) + 1HW at 50 DAS/IC	46	8.0	83.9	235.0	20.5	352.3	5.9	10.7	2642
T_6) Pendimethalin 0.75 kg/ha PE+ Quizalofop ethyl 100 g *a.i.*/ha (POE)	76	9.8	80.3	214.0	20.8	308.0	5.5	9.8	1956
T_7) Pendimethalin 0.75 kg/ha PE+ Quizalofop ethyl 100 g *a.i.*/ha (POE)+ 1 HW at 50 DAS/IC	41	13.3	73.3	247.3	21.6	404.0	6.5	11.5	2406
T_8) weed free	0.0	0.0	-	250.7	26.3	430.0	6.3	11.6	2647
T_9) weedy check	330	49.8	-	190.7	12.0	206.7	5.1	9.2	1477
Sem+	8.0	0.9	-	6.4	1.1	18.4	0.2	0.3	105.4
CD (P=0.05)	18.0	2.7	-	19.2	3.2	55.2	0.5	0.9	315.0
CV(%)	12.8	10.9	-	4.8	8.7	9.2	4.4	4.7	7.9

PE: pre-emergence application; POE: post- emergence application at 10-15 DAS and IC: Intercultication

Without integrated use of pendimethalin PE followed by imazathapyr POE or pendimethalin PE+ quizalofop ethyl POE with hand weeding/intercultivation at 50 DAS are known to provide lower grain yields than IWM treatments (pendimethalin PE followed by imazathapyr POE with hand weeding/intercultivation at 50 DAS and pendimethalin PE followed by quizalofop ethyl POE with hand weeding/intercultivation at 50 DAS) due to poor weed control as reflected in higher dry matter of weeds and lower WCE. 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 Dhonde *et al*. [11], Idupuganti *et al*. [10], Meena *et al*.[15], Singh and Sakhon [12], Sharma *et al*. [14] and Murali *et al*.[16].

CONCLUSIONS

From this study, it can be concluded that weed control is a limited factor for realising higher grain yields in pigeonpea. Apart from the weed free treatment, weeds can also be effectively and efficiently controlled with integration of pendimethalin as pre-emergence and imazathapyr as post-emergence followed by hand weeding/intercultivation at 50 DAS which ultimately results in higher grain yields of pigeonpea.

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