Effect of herbicidal treatment on weed dynamics of pigeon pea based intercropping system in rainfed condition of Kymore Plateau Madhya Pradesh

Comment [DS1]:
The authors' work is excellent and shows great effort, but the manuscript's language needs to be revised. The materials and methods need references.The results and discussion need more writing.Updated references are needed.

Abstract

A field experiment was conducted to evaluate the role of intercrops in respect of weed suppression and chemical methods for effective weed control in pigeon pea and green gram based intercropping systems. Results revealed that the relative density of dicot weeds was lower than the relative weed density of monocot weeds and did not show any significant effect on weed dynamics of pigeon pea and green gram based intercropping systems whereas, the application of Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha significantly minimum weed density, weed dry weight and maximum weed control efficiency recoreded compared to weedy plot at 25, 50 and 75 days after sowing (DAS). This might be due to reduction in weed competition.

Keywords: Herbicide, intercropping, weed dynamics, pigeon pea.

Introduction

Pigeon pea is one of the major grain legume crops of the tropical and subtropical regions. It is grown predominantly under rainfed conditions. Intercropping in India is mainly confined to rainfed cultivation. The merit of this system is to serve as kind of insurance against crop failure and increasing the risk bearing ability. Hence to setup the production level years after year and obtain maximum cost benefit ratio, optimum utilization of land and water resources by adopting efficient cropping system is of almost importance to meet challenge of population explosion. It is a pre-dominant tenure of the dryland farming system of the semi-arid topics. Over 50 per cent of the rainfed crops in Asia, Africa and Latin America which are grown under mixed intercropping system. In the recent past however, the consent of intercropping has changed. Now the system is geared to make efficient use of production resources, enhance per unit productivity and provide stability under adverse climatic condition.

The main concept of intercropping is to get increased total productivity per unit area and time, besides equitable and judicious utilization of land resources and farming inputs including labour. One of the main reasons for higher yield in intercropping is that the component crops are able to use growth resources differently and make better overall use of growth resources than grown separately (Willey, 1979). Sole pigeonpea gets heavily infested

with weeds due to wide row and plant to plant spacing, slow early growth of crop and frequent rains and inadequate sunlight during kharif season. The critical period is during the first eight weeks after sowing. Losses in grain yield caused by the weeds in pigeonpea are reported to the extent of 68 per cent in the peninsular zone. (Talnikar et al., 2008). Pigeonpea is a poor weed competitor and is very sensitive to weed competition during the first 60 days of its growth. It is a wide row planted crop and allows weeds to grow vigorously and multiply because of the poor canopy cover during the initial growth period. Emergence of weeds in pigeonpea begins simultaneously with the crop leading to severe weed competition right from the very early stages. Greengram is most essential pulse crop in India because of its shorter growth duration, low water demand, low soil fertility and is privileged for consumption due to its soft digestibility and low yield of flatulence (Dhandayuthapani, 2015). With this view, present field experiment was undertaken with objectives to assess the role of intercrops in respect of weed suppression and compare non chemical and chemical methods for effective weed control in pigionpea based intercropping systems.

Materials and Methods

The field experiment was conducted at the Rajoula Research Farm, M.G.C.G.V., Chitrakoot, Satna (M.P.) during *kharif* and *rabi* season of 2012-13. The experimental soil was sandy loam having fertility states of 120 kg N, 15 kg P_2O_5 and 291 kg K_2O/ha with electrical conductivity 0.20 ds/m and soil pH 7.46 were estimated by alkaline potassium permanganate method (Subbiah and Asija 1956), Olsen's method (Olsen et al. 1954) and 1 N NH4OAc (Hanway and Heidal, 1952), combined glass electrode pH meter method respectively. The treatments comprised two cropping systems (sole pigeonpea and pigeonpea + green gram 2:2 row ratio) the main plots and six weed management practices (weedy check, pendimethalin 1 kg ai/ha PE, oxyflyorfen 0.2 kg ai/ha PE, imazethapyr 0.1 kg ai/ha, postemer, pendimethalin + in azethapyr and oxyfluorfen + imazethapyr) in the sub-plots. The twelve treatment combinations were laid out in split plot design with three replications. Pigeonpea "ICPL 88039" and green gram "Samrat" were sown on 21 July 2012 keeping row to row 60 and 20 cm, and plant to plant 20 and 10 cm., respectively. The fertilizers were applied @ 20:60: 20 kg N: P_2O_5: K_2O/ha for both the crops.

The observations on population of major weeds and other associated weeds were recorded at 25, 50 and 75 days after sowing by quadrate count method. The quadrate of $1m^2$ (1mx 1m) was randomly thrown at four places in each plot species wise weed count and total number of

weeds m^2 were recorded. The percentage composition of weed flora was estimated from weedy check. The relative density of weeds was worked out as per formula at 25 DAS.

$$\text{Relative density (\%)} = \frac{\text{Number of individuals of the same species X 100}}{\text{Number of individuals of all species}}$$

Weed dry matter

Dry weight was worked out by placing a quadrate of $1m^2$ at four places randomly in each plot weed species were removed outside of the net area of each plot at 75 DAS. The weeds were kept in paper bags species wise and dried in oven at oven drying (70 ± 1^0C) and weighted after 48-54 hours till the constant weight was achieved. Dry weight was recorded on electronic balance in g/m^2

Weed control efficiency

The total weed biomass obtained before harvest was utilized to determine the weed control efficiency of various treatment using the following formula.

$$\text{Weed Control Efficiency (WCE)} = \frac{W_0\text{-}W_1 \text{ X } 100}{W_0}$$

Where:-

W_0 = Weeds dry weight in control weedy plots (g)

W_1 = Weed dry weight in treated plots (g)

Results and discussion

Associated weed flora

The weed flora asscociated with the crops are found in experimental field is shown in table-1 according to their botanical names, family and nature of cotyledons. *Amongst monocots, Cyperusrotundus*L(perenial Sedge)*; Cynodondactylon*(grassy weed) were observed in the experimental area. The associated annual dicot weeds were *Convolvulus arvensis*(perenial) also observed.Such associated weed problems might be because of the experimental field was fallow during past season and this favours the growing of kharif and rabisedgse and other propagules growing weeds (eg. *Cyprus routundus, cynodondactylen* etc.). Similar weeds were also found by (Bhalla *et al.*, 1998, Sukhadia*et al.*, 2000 and Tomar*et al.*, 2007).

Table:1 Associated weed flora at 25 DAS

S. No.	English Name	Botanical Name	Family
	Monocot Weeds		
1.	Johnson Grass	*Sorghum halepense*	Poaceae
2.	Doob Grass	*Cynodondactylon*	Graminae
3.	Nutgrass/ purple nut sedge	*Cyprus rotundus* L.	Cypraceae
4.	Sanwa grass	*Echinocloa spp.*	Poaceae
5.	Swollen finger grass	*Chlorisbarbata*	Poaceae
	Dicot weeds		
1.	Field bind weed	*Convolvulus arvensis* L.	Convolvulaceae
2.	JangliGobhi	*LauneaAsplenpfolia*	Compositae
3.	Pig weed	*Amaranthusvirdis*	Amaranthaceae
4.	Chaff plant	*Digeraarvensis*	Amaranthaceae

WEED POPULATION AND RELATIVE WEED DENSITY (%)

Pigeon pea and green gram faced the problem of both types of weeds viz. monocot (grassy) as well as dicot weeds during crop season. Total weed population and relative density of weedy control plots at 25, 50 and 75 DAS are presented in table -2. Perusal of the data revealed that monocot and dicot both weeds dominating during early crop season. The population of grassy weeds was 105.24/m^2 while dicot weeds were to the magnitude of 79.67/m^2 at 25 DAS. The relative density of dicot weeds was lower than the relative weed density of monocot weeds. Among the monocot weeds, the highest relative density was noted in *Echinocloa spp.* (31.41 %), *Cyprus rotundus* L (12.18 %) and lowest in *Sorghum halepense* (3.00 %). Among the dicot Weeds, *Digeraarvensis* (22.65 %) had the highest relative density followed by *Convolvulus arvensis* L. (8.84 %) and it was lowest was in case of *Amaranthusvirdis*(4.75 %).The primary stage of slow growing nature, long and short height of pigeon pea and green gram may be responsible for the weed infestation. Similar observation was also noted by Dangi (2012).

Table: 2 Composition of weed flora (weedy control plot) expressed in terms of relative density (%) at 25, 50 and 75 DAS

S. No.	Weed species	25 DAS		50 DAS		75 DAS	
		Weed population/ m^2	Relative density	Weed population/ m^2	Relative densit	Weed population/ m^2	Relative densit

			(%)		y (%)		y (%)
	Monocot Weeds						
1.	*Sorghum halepense*	5.54	3.00	7.55	4.48	20.98	13.15
2.	*Cynodondactylon*	11.52	6.23	10.35	6.14	19.85	12.45
3.	*Cyprus rotundus* L.	22.53	12.18	21.52	12.77	21.54	13.51
4.	*Echinocloa spp.*	58.11	31.43	41.2	24.45	21.54	13.51
5.	*Chlorisbarbata*	7.54	4.08	10.65	6.32	20.44	12.82
	Dicot weeds						
1.	*Convolvulus arvensis* L.	16.34	8.84	20.98	12.45	11.12	6.97
2.	*Commelinabengalensis*	12.65	6.84	10.98	6.52	13.54	8.49
3.	*Amaranthusvirdis*	8.79	4.75	9.56	5.67	17.34	10.87
4.	*Digeraarvensis*	41.89	22.65	35.69	21.18	13.14	8.24
	Total	**184.91**	**100.00**	**168.48**	**100.00**	**159.49**	**100.00**

TOTAL WEED POPULATION/M^2

Weed control measure significantly affected to the weed density/m^2 of pigeon pea and green gram field (Appendix II). A perusal of data table-3 revealed that higher number of weeds/m^2 was recorded during early stage of crop and it decreases with advancement in age of crop growth. At 25 DAS, weed density/m^2 was lowest in those treatments which had applied W_5: Pendimethalin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha gradually lower at 50 and 75 days stages of crop while, the weed density of control plot was higher till 90 days crop stages, while, Maximum values were observed in control.This might be due to reduction in weed competition. The above finding confirmed with the results of Ahuja and Cheema (1983), Ahuja *et al*., 1998, Shrivsatava*et al*. (2001), Patil and Pandey (1996) and Hemlata and Dewangan (2012).

Table:3 Effect of intercropping and weed management practices on weed density

Treatment	**Weed density (no. of weeds/m^2)**		
	25 DAS	**50 DAS**	**75 DAS**

Cropping system			
I_1: sole pigeon pea	57.56	64.61	99.33
I_2: pigeon pea + green gram (2:2)	53.39	57.78	99.28
SEm ±	**0.77**	**1.43**	**9.63**
CD (P=0.05)	**NS**	**NS**	**NS**
Weed management			
W_1: Weedy check	189.33	180.83	163.50
W_2: Pendimethalin @ 1kg ai/ha	36.17	53.67	146.50
W_3: Oxyfluorfen @ 0.2 kg ai/ha PE	43.67	53.00	112.17
W_4: Imazethapyr @ 0.1 kg ai/ha	24.33	29.50	87.17
W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha	15.83	13.83	39.67
W_6: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha	23.50	36.33	46.83
SEm ±	**1.93**	**9.70**	**18.01**
CD (P=0.05)	**5.68**	**28.60**	**53.13**

TOTAL DRY MATTER OF WEEDS (G/M^2)

Weed dry matter (g/m^2) of pigeon pea + green gram field was significantly affected due to various weed control measures at all the stages of crop. Weed dry matter increased with advancement in age of the crop growth i.e. up to 50 days stage. Thereafter, it reduced with the crop age table - 4. At 75 days stage, the weed dry weight reduced probably due to lower weed density and crop shedding effect on weed growth. The results showed that maximum weed dry matter in control plot (177.83, 243.83 and 186.67 g) and minimum weed dry matter in W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha (2.34, 15.04 and 11.63 g) at all the stage crop. Weed dry matter (gram/m^2) was significantly affected by different weed management practices at 25, 50 and 75 DAS.Shrivsatava*et al*. (2001) reported that application of Pendimethalin significantly reduced the weed population and weed dry weight compare to weedy control, while Nirala*et al*., 2012 and Hemlata and Dewangan (2012) found the positive effects of weedicide Imazethapyr in controlling weeds.

Table:4 Effect of weed management and intercropping practices on weed dry matter

Treatment	Weed dry matter (g)		
	25 DAS	50 DAS	75 DAS
Cropping system			
I_1: sole pigeon pea	58.61	127.56	94.39
I_2: pigeon pea + green gram (2:2)	51.33	101.06	103.61
SEm ±	**1.68**	**11.14**	**5.44**
CD (P=0.05)	**NS**	**NS**	**NS**
Weed management			
W_1: Weedy check	177.83	243.83	186.67
W_2: Pendimethalin @ 1kg ai/ha	37.67	107.67	148.00
W_3: Oxyfluorfen @ 0.2 kg ai/ha PE	48.00	156.00	105.17
W_4: Imazethapyr @ 0.1 kg ai/ha	24.33	64.33	77.67
W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha	14.50	28.00	34.50
W_6: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence	27.50	86.00	42.00
SEm ±	**2.34**	**15.04**	**11.63**
CD (P=0.05)	**6.91**	**44.38**	**34.32**

Weed control efficiency

Weed control efficiencies under different treatments was worked out and the analyzed data are presented in table-5. The data showed that the weed control efficiency under different intercropping treatment was statistically non-significant, but it was significantly affected by various weed management practices. Among the weed management practices, the weed control efficiency of (91.93, 87.4 and 80 per cent) were recorded highest under W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha at 25, 50 and 75 DAS, respectively followed by W_4: Imazethapyr @ 0.1 kg ai/ha at 25 and 50 DAS, while it was recorded maximum with W_6: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha at 75 DAS.

Table:5 Weed control efficiency under different cropping system and weed management practices

Treatment	Weed control efficiency		
	25 DAS	**50 DAS**	**75DAS**
Cropping system			
I_1: sole pigeon pea	68.36	42.24	39.24
I_2: pigeon pea + green gram (2:2)	69.79	61.38	49.70
SEm ±	**0.70**	**7.01**	**4.40**
CD (P=0.05)	**NS**	**NS**	**NS**
Weed management			
W_1: Weedy check	0.00	0.00	0.00
W_2: Pendimethalin @ 1kg ai/ha	78.75	52.79	18.23
W_3: Oxyfluorfen @ 0.2 kg ai/ha PE	72.82	34.22	38.45
W_4: Imazethapyr @ 0.1 kg ai/ha	86.36	73.33	55.71
W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha	91.93	87.40	80.00
W_6: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence	84.60	63.12	74.44
SEm ±	**0.88**	**5.97**	**4.71**
CD (P=0.05)	**2.61**	**17.61**	**13.88**

Such higher weed control efficiencies might be due to use of integration of pre and post emergence weedicides for weed control. Similar findings were also reported by Shrivsatava*et al.* (2001) and Nirala*et al*., 2012.

Table:6 Effect of weed management and intercropping practices on seed yields of pigeon pea and green gram

Treatment	Seed yield of pigeon pea (kg/ha)	Seed yield of green gram (kg/ha)
Cropping system		
I_1: sole pigeon pea	1136.68	0.00
I_2: pigeon pea + green gram (2:2)	1119.67	738.09
SEm ±	**9.65**	**15.59**
CD (P=0.05)	**NS**	**17.92**

Weed management		
W_1: Weedy check	917.70	535.18
W_2: Pendimethalin @ 1kg ai/ha	1151.38	796.29
W_3: Oxyflorfen @ 0.2 kg ai/ha PE	1027.08	544.29
W_4: Imazethapyr @ 0.1 kg ai/ha	1034.37	698.14
W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha	1326.73	979.62
W_6: Oxyflorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence	1311.80	874.99
SEm ±	**20.10**	**19.20**
CD (P=0.05)	**59.28**	**56.65**

Seed yield (Kg/ha)

Seed yield of pigeon pea sole (11.36.68 kg/ha) was recorded higher than I_1: sole pigeon pea (1119.67 kg/ha. In weed management, W_5: Pendimethelin @ 1.0 kg ai+ Imazethapyr @0.1 kg ai/ha (1126.77 kg/ha) gave significantly higher seed yield than rest of weed management treatments and is at par with W_6: Oxyflorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence (1311.80 kg/ha). Minimum seed yield was recorded in weedy check treatment. This could be ascribed due to greater value of growth parameter i.e. plant height, plant dry weight, nodules/plant and their dry weight and yield attributes, pods/plant. Such trend might be due to better spatial arrangement of pigeon pea under sole as well as inter cropping system with 2:2 row ratios. The row ratio of pigeon pea + green gram could be associated with least completion of main crop pigeon pea with intercrop green gram. Sarma*et al.* (1995), Rao *et al.* (2007). In weed management, these seed yields of pigeon pea were obtained significantly greater under the treatment W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha followed by W_6: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha post emergence. The higher seed yield might be due to significantly greater yield attributes and better growth environments. Such enhancement might be due to least completion between crop plant and weeds which resulted better interception and utilization of radiant energy leading to higher photosynthesis and finally improvement yield of pigeon pea. The results confined to the findings of Hemlata and Dewangan (2012); Shrivsatava*et al.* (2001) and Nirala*et al*., 2012.As there was the crop of green gram was ablsent under treatment I_1: sole pigeon pea, the seed yield of green gram was

recorded significantly higher as 738.09 kg/ha under the single cropping system treatment compared I_2: PP+GG (2:2).Such trend might be due to better spatial arrangement of green gram under intercropped condition with 2:2 row ratios. Pujari and Sheelvantar (2002), Goyal*et al*. (1991) reported the similar findings in their experiments. In weed management treatment, application of W_5: Pendimethelin @ 1.0 kg ai + Imazethapyr @0.1 kg ai/ha (979.62 kg/ha) gave significant higher seed yield followed by W_6: Oxyfluorfen @ 0.2 kg ai/ha PE + Imazethapyr @0.1 kg ai/ha (874.99 kg/ha). Significantly minimum values were obtained under in weedy check treatment (535.18 kg/ha). The seed yield under W_5 and W_6 was recorded 83.04 and 63.49 per cent higher as compared to the seed yield obtained under W_1: Weedy check.This increase might be due to lower crop weed completion that favours better crop growth and make available more space for crops. Similar are the findings reported by Aziz and Rahman (1995).

Conclusion

On the basis of results obtained from the experiment, It can be concluded that weed can be managed efficiently by application of the pre-emergence weedicide Pendimethelin @ 1.0 kg ai with post emergence weedicide Imazethapyr @0.1 kg ai/ha (W_5) or by pre-emergence weedicide Oxyfluorfen @ 0.2 kg ai/ha with post emergence weedicide Imazethapyr @ 0.1 kg ai/ha ((W_6). These weedicides were found efficient in controlling weeds and in relation to higher yield attributes, seed and straw yield of pigeon pea and green gram and gross return, net return of pigeon pea and green gram.

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