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Effect of weed control and cropping system on weed population and productivity of maize grown sole or intercropped with pulses

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ABSTRACT

A field experiments was conducted in Agricultural College and Research Institute, Madurai, Tamil Nadu Agricultural University during rabi season of 2013 with an objective to study the weed interference and productivity of maize in different intercropping situation. The experimental soil was clay loam of Madukur Series with neutral pH. The experiments were laid out in split plot design with three replications. The main plots were consisted with cropping system, viz. maize, maize + blackgram, maize + cowpea and weed management practices such as pre emergence (PE) application of pendimethalin at 0.75 kg ha^{-1}, alachlor at 1 kg ha^{-1} and oxyfluorfen at 0.2 kg ha^{-1} and in combination with one rotary hoeing on 35 DAS. In addition to this, rotary hoeing twice at 15 and 35 DAS, hand weeding on 15, 35 DAS and unweeded check were assigned to sub plots. The experimental results revealed that total weed population and weed DMP, were higher in sole maize cropping than intercropping situation. Among the IWM treatments pre emergence application of pendimethalin at 0.75 kg ha^{-1} followed by one rotary hoeing on 35 DAS resulted lesser weed population and higher weed control efficiency (85.88). The weed control cum smothering efficiency under maize + cowpea system resulted significantly higher (74.40) than maize + blackgram system (73.66). The application of pendimethalin at 0.75 kg ha^{-1} + rotary hoeing on 35 DAS has higher yield components and produced significantly higher grain yield of maize 6051 kg ha^{-1}.

Keywords : Intercropping, IWM, productivity of maize, weed interference, weed control efficiency.

Maize is one of the main foods for millions of people due to compatibility with different climatic conditions. Also, its area harvest has the third place around the world (Liebman *et al.*, 2001). Maize is most sensitive to weeds competition especially during early stage of crop growth. It grows slowly during first 3 to 4 weeks. The highest damage is caused by weeds, pests and diseases. This damage is estimated between 10 to 15 per cent of total production in developed countries in temperate zones, so it is more in developing countries in tropics zone. Therefore, the farmers sometimes spend more than half struggle to control weeds (Rashed *et al*., 2001). Weeds compete with crop in different ways, and decrease quality and quantity of agricultural products. Results of some studies showed that weeds are able to use nutrition of soil more than crops (Rashid *et al.,* 2008). The weeds can grow in the beginning season due to the use of feature that reduces potency of competition plants by creating food shortages. The intensive use of a limited number of herbicides creates a situation where herbicide resistance is more likely to develop. Presently, 58 weed species in corn are resistant, which is the second highest after wheat. Rainy-season maize suffers heavy yield losses ranging from 28 - 100 per cent due to weed infestation owing to congenial environment for luxurious weed growth. Combination of different methods of weed management appears necessary due to importance of weed management in corn crop and the researchers recommended the use IWM in agriculture, also, in order to increase more and healthier produce. The aim of this study was to determine the effects of intercropping system and weed management practices in maize during Rabi season on weed interference and maize yield.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2013 at Agricultural College and Research Institute, Madurai, TNAU. The experimental site is situated at 9°54' N latitude and 78°54' 'E' longitude at an altitude of 147m above MSL. The soil of the experimental field was well drained clay loam of Madukur Series. The soil was low, medium and high in available status of N, P_2O_5 and K_2O respectively. The recommended fertilizer schedule of 250:75:75 kg NPK ha^{-1} was applied in maize crop. The entire quantity of P and K and 50 per cent of N were applied as basal in the sowing lines of maize. The remaining quantity of nitrogen was applied as two equal splits on 30 and 45 DAS. Investigation was carried out in split plot design with three replications. The main plots were assigned with cropping system, *viz*. maize, maize + blackgram, maize + cowpea and weed management practices such as pre emergence (PE) application of pendimethalin at 0.75 kg ha^{-1}, alachlor at 1 kg ha^{-1} and oxyfluorfen at 0.2 kg ha^{-1} and in combination with one rotary hoeing on 35 DAS. In addition to this, rotary hoeing twice at 15 and 35 DAS, hand weeding on 15, 35 DAS and unweeded check were assigned to sub plots. Test crops are maize hybrid, black gram and cowpea with varieties of '*COHM 6*', '*VBN (Bg) 4*' and '*VBN1*', respectively. In sole maize, crop were raised with a

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spacing of 60 x 25 cm with the population of 66666 plants ha^{-1} while pulses intercropped with maize were followed the paired row system with spacing of 90 x 30 x 90 cm with unaltered population per hectare. Where, in between two paired rows of maize two rows of pulses were introduced with a spacing of 30 x 15 cm. The experimental plot size was 5 x 4 m.

The weed count was taken at 15, 35 and 60 DAS. The weed count was recorded group-wise *viz*., grasses, sedges and broad leaved weed using 0.25 m^2 quadrat from four randomly selected fixed places in each plot and expressed in number m^{-2} as suggested by Burnside and Wicks, 1965. Weeds found within two 0.50 m^{-2} quadrat were removed, sun dried and then oven dried at 70 ^{0}C for 72 hours. The dry weight of the weeds were assessed and expressed in kg ha^{-1}. Weed control efficiency was calculated as per the procedures given by Mani *et al.,* 1973) and expressed in percentage.

$$WCE = \frac{WDC - WDT}{WDC} \times 100$$

Where,

WDC - Weed dry weight in control plot (kg ha^{-1}), WDT - Weed dry weight in treatment plot (kg ha^{-1})

RESULTS AND DISCUSSION

The application of pendimethalin @ 0.75 kg ha^{-1} as pre emergence followed by one rotary hoeing in maize + cowpea, maize + blackgram intercropping system resulted significantly lesser weed population than in sole maize (Table 1). The reduction in weed density in intercropping systems may be attributed to shading effect and competition stress created by the canopy of more crops in a unit area having suppressive effect on associated weeds, thus preventing the weeds to attain full growth, Pandey *et al.* (2003). The intercropping suppressed the weed growth due to their spreading canopy coverage. The increased populations per unit area and crop competition in intercropping were also the possible reason for effective weed control (Jayaraj, 1991).

Weed DMP

Weed dry weight is the most important parameter to access the weed competitiveness for the crop growth and productivity. Weed control practices through application of pre-emergence herbicides reduced the total DMP when compared to rotary hoeing and hand weeding at 15 and 35 DAS and unweeded check throughout the crop period. Weed DMP in maize + cowpea, maize + blackgram intercropping system were lesser than in sole maize. Weed dry matter accumulation in intercropping systems may be attributed to shading effect and competition stress created by the canopy of more number of crops in a unit area having suppressive effect on associated weeds, thus preventing the weeds to attain full growth, Pandey *et al.* (2003).

Weed control efficiency

The weed control efficiency in rotary hoeing and hand weeding at 15 and 35 DAS was comparatively less than that of the pre-emergence herbicides application with one rotary hoeing. This might be due to initial rank weed growth under irrigated condition up to the implementation of mechanical weeding at 15 and 35 DAS and subsequent emergence of grasses, sedges and broad leaved weeds. The maximum WCE obtained by the IWM practices was due to greater reduction of grasses, sedges and broad leaved weeds in all the stages of crop growth itself which in turn increased the vigor and growth of maize and cowpea, blackgram resulted in good crop establishment. It might be due to shorter persistence nature of pre-emergence herbicides in soil which control the weeds for a shorter period and lead to lower weed density and DMP. Pendimethalin @ 0.75 kg ha^{-1} fb one rotary hoeing under maize + cowpea intercropping system recorded higher weed control efficiency, (Sinha *et al.,* 2003).

Weed index

Weed index is a measure of yield loss caused due to varying degree of weed competition compared to the relatively weed free condition throughout the crop period leading to higher productivity. Weed index was lower in all the herbicide applied treatments than other weed control treatments. Application of pendimethalin @ 0.75 kg ha^{-1} as pre-emergence followed by one rotary hoeing was the best treatment as it resulted in reduced weed population. Reduction in grain yield was caused by reduced in growth and yield components of maize under increased pressure of weed competition for space, light, nutrients etc., (Haque *et al*., 2013). The largest yield reduction was observed in unweeded check. This was due to high degree of crop weed competition in nutrients and space etc.

Weed control cum smothering efficiency

Intercropping and weed control treatments appreciably influenced the weed control cum smothering efficiency. Maize + cowpea intercropping system registered the highest weed control cum smothering efficiency value of 58.48, 59.34 and 74.40 per cent on 15, 35 and 60 DAS. Pre-emergence application of pendimethalin @ 0.75 kg ha^{-1} + one rotary hoeing (W_1) recorded the higher WCSE of 59.30, 58.48 and 59.55 percent on 15, 35 and 60 DAS (Table 4). It might be due to shading effect and competition stress created by the canopy of more crops in a unit area having suppressive effect on associated weeds, thus preventing the weeds to attain full growth (Dwivedi *et al.,* 2012).

Table 1: Total weed population as influenced by intercropping system and weed management practices ($No.m^{-2}$)

Treatments	**15 DAS**	**35 DAS**	**60 DAS**
Cropping system			
C_1- Maize alone	(49.93)7.07	(56.31)7.50	(89.09)9.44
C_2- Maize + Blackgram	(41.89)6.47	(44.50)6.67	(70.29)8.38
C_3- Maize + Cowpea	(35.82)5.98	(36.56)6.05	(58.16)7.63
SEd	**0.54**	**0.79**	**1.19**
LSD (0.05)	**1.52**	**2.21**	**3.30**
Weed control treatments			
W_1-PE Pendimethalin + one Rotary hoeing	(21.06)4.59	(21.50)4.64	(42.41)6.51
W_2- PE Alachlor + one Rotary hoeing	(27.56)5.25	(31.28)5.59	(56.89)7.54
W_3- PE Oxyfluorfen + one Rotary hoeing	(33.69)5.80	(37.69)6.14	(70.89)8.42
W_4- Rotary hoeing twice (15 & 35 DAS)	(38.81)6.23	(41.05)6.41	(78.34)8.85
W_5- Hand weeding twice (15 & 35 DAS)	(45.58)6.75	(45.61)6.75	(78.83)8.88
W_6- Unweeded check	(84.83)9.21	(101.33)10.07	(136.56)11.69
SEd	**0.95**	**0.99**	**1.82**
LSD (0.05)	**1.94**	**2.03**	**3.73**
C at W			
SEd	**1.60**	**1.76**	**3.12**
LSD (0.05)	**3.41**	**3.87**	**6.71**

Table 2: Weed DMP as influenced by intercropping system and weed management practices ($kg\ ha^{-1}$)

Treatments	**15 DAS**	**35 DAS**	**60 DAS**
Cropping system			
C_1- Maize alone	(223.62)14.17	(228.57)14.31	(255.43)14.96
C_2- Maize + Blackgram	(179.93)12.48	(182.63)12.50	(194.51)12.83
C_3- Maize + Cowpea	(155.65)11.67	(155.37)11.63	(189.04)12.61
SEd	**0.22**	**0.24**	**0.24**
LSD (0.05)	**0.60**	**0.66**	**0.67**
Weed control treatments			
W_1-PE Pendimethalin + one Rotary hoeing	(51.23)7.08	(57.42)7.45	(92.62)9.52
W_2- PE Alachlor + one Rotary hoeing	(72.13)8.42	(69.50)8.16	(103.57)10.08
W_3- PE Oxyfluorfen + one Rotary hoeing	(79.63)8.87	(78.00)8.74	(120.67)10.90
W_4- Rotary hoeing twice (15 & 35 DAS)	(290.53)16.99	(291.28)16.98	(148.39)12.13
W_5- Hand weeding twice (15 & 35 DAS)	(302.50)17.35	(302.49)17.32	(164.00)12.72
W_6- Unweeded check	(322.37)17.92	(334.45)18.26	(648.70)25.44
SEd	**0.17**	**0.52**	**0.37**
LSD (0.05)	**0.36**	**1.07**	**0.77**
C at W			
SEd	**0.35**	**0.86**	**0.64**
LSD (0.05)	**0.81**	**NS**	**NS**

Figures in the paranthesis are original values. Others are square root transformed [SQR (X+0.5)] values.

Table 3: Weed control efficiency and weed index as influenced by intercropping system and weed management practices

Treatments	Weed control efficiency (%)			Weed index
	15 DAS	35 DAS	60 DAS	(60 DAS)
Cropping system				
C_1- Maize alone	40.35	40.18	65.41	52.56
C_2- Maize + Blackgram	42.66	43.15	68.12	43.82
C_3- Maize + Cowpea	44.09	48.21	68.36	29.28
Weed control treatments				
W_1-PE Pendimethalin + one Rotary hoeing	84.36	83.10	85.88	13.34
W_2- PE Alachlor + one Rotary hoeing	77.94	79.60	84.19	25.17
W_3- PE Oxyfluorfen + one Rotary hoeing	75.49	76.90	81.56	37.57
W_4- Rotary hoeing twice (15 & 35 DAS)	10.06	13.32	77.25	50.91
W_5- Hand weeding twice (15 & 35 DAS)	6.37	10.17	74.92	55.74
W_6- Unweeded check	-	-	-	68.57

Table 4: Weed control cum smothering efficiency as influenced by intercropping system and weed management practices

Treatments	Weed control cum smothering efficiency (%)		
Cropping system	**15 DAS**	**35 DAS**	**60 DAS**
C_1- Maize alone	-	-	-
C_2- Maize + Blackgram	52.00	52.21	73.66
C_3- Maize + Cowpea	58.48	59.34	74.40
Weed control treatments			
W_1-PE Pendimethalin + one Rotary hoeing	59.30	58.48	59.55
W_2- PE Alachlor + one Rotary hoeing	56.04	57.21	58.63
W_3- PE Oxyfluorfen + one Rotary hoeing	54.53	54.89	57.23
W_4- Rotary hoeing twice (15 & 35 DAS)	18.69	20.12	54.74
W_5- Hand weeding twice (15 & 35 DAS)	18.40	19.92	53.82
W_6- Unweeded check	-	-	-

Table 5: Yield parameters of maize as influenced by intercropping system and weed management practices

Treatments	Cob length (cm)	Cob girth (cm)	Number of grains cob^{-1}	Test weight (g)
Cropping system				
C_1- Maize alone	13.75	12.77	442.44	30.17
C_2- Maize + Blackgram	15.53	13.11	463.56	31.89
C_3- Maize + Cowpea	16.83	14.47	490.67	34.06
SEd	**0.50**	**0.49**	**12.92**	**1.05**
LSD (0.05)	**1.38**	**1.35**	**35.86**	**2.91**
Weed control treatments				
W_1-PE Pendimethalin + one Rotary hoeing	19.11	15.72	558.00	36.67
W_2-PE Alachlor + one Rotary hoeing	17.17	14.22	530.78	33.56
W_3-PE Oxyfluorfen + one Rotary hoeing	16.00	13.78	506.00	32.44
W_4-Rotary hoeing twice (15 & 35 DAS)	15.06	12.39	481.56	31.33
W_5- Hand weeding twice (15 & 35 DAS)	13.00	13.37	401.56	30.33
W_6- Unweeded check	11.89	11.23	315.44	27.89
SEd	**0.70**	**0.64**	**14.23**	**0.92**
LSD (0.05)	**1.43**	**1.31**	**29.07**	**1.88**
C at W				
SEd	**1.21**	**1.12**	**25.95**	**1.79**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**

Yield parameters

The yield components of maize *viz*., cob length, cob girth, number of grains per cob and test weight were higher under maize + cowpea intercropping system. This might be due to the complementary effect of cowpea which favoured the source-sink relation in maize and produced better yield components resulted in higher maize grain yield, (Chalka and Nepalia, 2006).The yield components of maize in maize + blackgram showed more or less equal value as that of sole maize. Higher accumulation of dry matter with better weed control caused improvement of the various yield parameters and yield of maize. Thus, Application of pendimethalin @ 0.75 kg ha^{-1} fb one rotary hoeing produced lengthier cob, increased cob girth, more grain number cob^{-1} and higher test weight over unweeded check, (Sen *et al*., 2000).

Table 6: Grain and straw of maize as influenced by intercropping system and weed management practices

Treatments	Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})
Cropping system		
C_1- Maize alone	3312	9939
C_2- Maize + Blackgram	3922	11769
C_3- Maize + Cowpea	4938	14815
SEd	**133.5**	**400.5**
LSD (0.05)	**370.6**	**1112.0**
Weed control treatments		
W_1-PE pendimethalin + one rotary hoeing	6051	18154
W_2-PE alachlor + one rotary hoeing	5225	15675
W_3-PE oxyfluorfen + one rotary hoeing	4359	13078
W_4-Rotary hoeing twice (15 & 35 DAS)	3428	10284
W_5- Hand weeding twice (15 & 35 DAS)	3090	9271
W_6- Unweeded check	2194	6583
SEd	**255.9**	**767.7**
LSD (0.05)	**522.6**	**1567.9**
C at W		
SEd	**426.0**	**1278.2**
LSD (0.05)	**900.8**	**2702.6**

Grain yield

The increase grain yield were registered with the application of pendimethalin @ 0.75 kg ha^{-1} as pre-emergence fb one rotary hoeing under maize + cowpea intercropping system.. This might be due to better control of all categories of weeds. In addition to that, lower nutrient depletion and lesser DMP of weeds and thereby increasing the nutrient uptake by crop influenced the growth and yield attributes which favoured grain yield of maize (Walia *et al*., 2007). The integrated weed management practices viz., caused 3.5 to 11.90 percent yield increase over rotary hoeing and hand weeding twice. The yield increase with IWM over mechanical weeding was due to the effective control of weeds by IWM whereas mechanical weeding though gave better weed control but also promoted the rapid growth of weeds, (Srikrishnah *et al*., 2008).

Straw yield

Different cropping system and weed control treatments influenced the stover yield significantly. Among the different cropping system, maize + cowpea system recorded a higher stover yield of 14815 kg ha^{-1} followed by maize + blackgram intercropping system (11769 kg ha^{-1}). The lowest stover yield was recorded at sole maize (9939 kg ha^{-1}). Maize Stover yield exhibited significant variation due to the different weed control treatments. Pre-emergence application of pendimethalin @ 0.75 kg ha^{-1} + one rotary hoeing resulted in higher stover yield (18154 kg ha^{-1}) which was significantly superior to all other weed control treatments. Unweeded check recorded the lowest Stover yield of 6583 kg ha^{-1}. The interaction effect of cropping system and weed management on the stover yield of maize was significant. Maize + cowpea with pre-emergence application of pendimethalin @ 0.75 kg ha^{-1} + one rotary hoeing recorded higher stover yield of maize 20949 kg ha^{-1} followed by pre-emergence application of alachlor @ 1.0 kg ha^{-1} + one rotary hoeing (Table 6).

From the experimental results, it could be concluded that, the pre emergence application of pendimethalin @ 0.75 kg ha^{-1} followed by rotary hoeing on 35 DAS recorded lesser weed density, dry weight, higher weed control efficiency and produced the higher yield attributes and grain yield of maize under maize based cowpea intercropping.

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