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Full Length Research Paper

Effects of herbicides and manual weeding on weed management and tomato yield in Ado Ekiti, Nigeria

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Two trials were conducted to evaluate the effects of herbicides and manual weeding on weed management and tomato yield in Ado Ekiti, a southwestern Nigerian location. Pendimethalin at the rate of 1.25 kg a.i.ha^{-1} was applied pre-transplanting on ridges; Paraquat was applied post-transplanting as supplementary to earlier treatments at the rate of 2.4 kg a.i.ha^{-1} and manual weeding was done at 3 and 7 weeks after transplanting. The herbicide combinations provided the best weed suppression in terms of weed density and biomass reductions. Field establishment count showed that the herbicides used did not pose lethal effect on the tomato plant. Comparable yield figures were obtained from plots sprayed with the herbicide combinations: manual weeding + herbicide combinations and manual weeding at 3 and 7 weeks after transplanting (WAT). Pendimethalin applied pre-transplanting without a supplementary weed management could not give a season long weed management and thus led to lower tomato yield.

Key words: Tomato, pendimethalin, paraquat, manual weeding, yield.

INTRODUCTION

Tomato, *Lycopersicon esculentum*, is the world's most widely grown vegetable crop (Yoon et al., 1989). The crop had been grown for many years by peasant farmers in Nigeria but the yields are often low due to low yield in varieties, diseases, pest, poor soil fertility and weed infestation (Akintoye, 2003). Weeds compete with crops for water, light, nutrients and space, thus reducing crop yields and also affect the efficient use of machinery (Won, 2007). Although weed control has always been an important component of tomato production, its importance has increased with the introduction of sweet potato white fly. The increase incidence of several viral disorders of tomato reinforces the need for good weed control as the weeds play hosts to many pests including the white fly (Stall and Gilreath, 2003; William, 2008).

Herbicides and soil fumigants have been used mostly to control weeds in strawberries (Fennimore et al., 2003; Stall and Gilreath, 2002). Since pre-transplant herbicide applications do not control germination of late-season weed species, soil fumigants and herbicides are frequently combined to improve weed control efficacy (Noling and Gilreath, 2003). This approach has been previously examined in tomato (*Lycopersicon esculentum* Mill.), bell pepper (*Capsicum annuum* L.), and cucumber (*Cucumis sativus* L.), successfully reducing southern crabgrass, goosegrass (*Eleusine indica* L.), smooth pigweed (*Amaranthus hybridus* L.), and purple and yellow nutsedges densities (Noling and Gilreath, 2003; Gilreath and Santos, 2004; Gilreath et al., 2004).

Little attention had been paid to the possibility of herbicidal weed control in tomato in Ekiti State while the traditional hand weeding remained the main weed management system. This manual weeding had been reported to be uneconomical as net returns are very low when compared with herbicidal weed control (Akinyemiju and Alimi, 1989; Kukula, 1985; Ademiluyi, 2004). The present study aimed to examine the comparative effects of manual weeding and herbicides on weed management and fruit yield of tomato.

MATERIALS AND METHODS

Two field trials were conducted in the cropping seasons of 2010 and 2011 at the experimental site of the

Table 1. Effect of weed management practices on weed density at 5 and 9WAT.

Treatment	Weed density number (m^{-2})			
	2010		2011	
	5WAT	9WAT	5WAT	9WAT
Weedy check	22^{a}	38^{a}	45^{a}	65^{a}
Manual weeding at 3 and 7WAT	11^{b}	12^{c}	20^{b}	16^{c}
Manual weeding + Paraquat	12^{b}	8^{d}	18^{b}	11^{d}
Pendimethalin	7^{c}	21^{b}	9^{c}	24^{b}
Pendimethalin + manual weeding	3^{d}	7^{d}	8^{c}	6^{e}
Pendimethalin + Paraquat	8^{c}	5^{d}	10^{c}	3^{e}

Means with the same letter(s) within columns are not significantly different (P=0.05).

Table 2. Effect of weed management practices on weed biomass at 5 and 9WAT.

Treatment	Weed Biomass (kg m^{-2})			
	2010		2011	
	5WAT	9WAT	5WAT	9WAT
Weedy Check	206.5^{a}	283.8^{a}	216.5^{a}	309.4^{a}
Manual weeding at 3 and 7WAT	45.0^{b}	38.1^{b}	51.7^{b}	35.0^{b}
Manual weeding + Paraquat	48.2^{b}	7.4^{c}	47.5^{b}	12.1^{c}
Pendimethalin	21.7^{c}	46.9^{b}	19.6^{c}	34.7^{b}
Pendimethalin + manual weeding	20.5^{c}	6.4^{c}	21.2^{c}	11.8^{c}
Pendimethalin + Paraquat	22.0^{c}	5.7^{c}	20.4^{c}	10.6^{c}

Means with the same letter(s) within columns are not significantly different (P=0.05).

Department of Plant Science, Ekiti State University, Ado Ekiti (7°40'N, 5°15'E). The soil was described as sandy loam clay Alfisol (54% sand, 24% silt and 22% clay) with a pH of 6.5 and 6.2 in 2008 and 2009 respectively. The soil samples were analyzed to contain organic matter content of 4.2 and 3.8% in 2008 and 2009 respectively. The location is characterized by a bimodal rainfall pattern with an annual mean of about 1450 mm. The raining season lasts from March to November with a short dry spell in August. The sites were manually cleared, thrashes packed and ridged. Each ridge was 4 m long with an inter-row distance of 0.75 m. Four ridges were employed per treatment and tomato seedlings of 3 weeks old (Ademiluyi, 2010) were transplanted in March of each year. The following weed management programs were employed as follows: (a) manual weeding at 3 and 7 weeks after transplanting (WAT); (b) Pendimethalin; (c) Pendimethalin + Paraquat; (d) manual weeding at 3WAT + Paraquat at 6WAT; and (e) weedy check control.

Pendimethalin was applied a day after ridging and tomato seedlings were transplanted three days later. Supplementary Paraquat was applied inter-row at 7WAT where applicable. Pendimethalin and Paraquat were applied at the rate of 1.25 and 2.4 kg active ingredient per hectare (a.i.ha^{-1}) respectively. Manual weeding was effected using the Nigerian hoe at 3 and 7WAT.

Weed density and biomass were determined at 6WAT using 1 m^2 quadrant. Collected weed samples were counted, separated by species, oven dried at 80°C for 24 h and subsequently weighed. Fruits were regularly harvested from five randomly selected plants, counted and weighed over a period of four weeks to determine the yields. All data were statistically analyzed and means separated using the Duncan's Multiple Range Test.

RESULTS

The result of the effects of weed management practices on weed density is presented in Table 1. The lowest weed density was recorded in the Pendimethalin + manual weeding plots at 5WAT in both seasons. At 9WAT, Pendimethalin + Paraquat recorded the lowest density which was not significantly different from Pendimethalin + manual weeding. In 2010 trial, manual weeding + Paraquat gave comparable weed density reduction with Pendimethalin + Paraquat at 9WAT. Manual weeding + Paraquat gave significant higher weed density reduction than manual weeding alone at 9WAT. Weed density was highest at 9WAT in the pendimethalin applied plots when compared with other weed management practices.

Table 2 shows the effect of weed management practices on weed biomass at 5 and 9 WAT. Pendimethalin gave lower weed biomass than manual

Table 3. Effect of weed management practices on % field establishment.

Treatment	Establishment count at 10WAT	
	2010	2011
Weedy check	87.2[b]	84.5[b]
Manual weeding at 3 and 7WAT	99.5[a]	100.0[a]
Manual weeding + Paraquat	97.0[a]	98.1[a]
Pendimethalin	95.6[a]	97.4[a]
Pendimethalin + manual weeding	96.1[a]	97.0[a]
Pendimethalin + Paraquat	94.8[a]	96.4[a]

Means with the same letter(s) within columns are not significantly different (P=0.05).

Table 4. Effect of weed management practices on number of fruits per plant.

Treatment	Number of fruits plant^{-1}	
	2010	2011
Weedy check	8.1d	5.6c
Manual weeding at 3 and 7 WAT	32.0c	34.6b
Manual weeding + Paraquat	36.0a	37.8a
Pendimethalin	33.5bc	31.9b
Pendimethalin + manual weeding	35.3ab	37.6a
Pendimethalin + Paraquat	36.4a	38.1a

Means with the same letter(s) within columns are not significantly different (P=0.05).

Table 5. Effect of weed management practices on fruit yield (t/ha^{-1}).

Treatment	Fruit yield (t ha^{-1})	
	2010	2011
Weedy check	6.6c	6.9c
Manual weeding at 3 and 7 WAT	31.3a	27.6a
Manual weeding + Paraquat	30.6a	28.4a
Pendimethalin	25.7b	23.2b
Pendimethalin + manual weeding	33.4a	27.1a
Pendimethalin + Paraquat	33.9a	29.5a

Means with the same letter(s) within columns are not significantly different (P=0.05).

weeding in the 5WAT assessment. At 9WAT, manual weeding + Paraquat led to reduction in weed biomass more than manual weeding at 3 and 7WAT in both seasons. Also, Pendimethalin with supplementary manual weeding at 7WAT or supplementary Paraquat application at 7WAT gave comparable weed biomass values which were lower than Pendimethalin applied plots without supplementary weeding. Weedy check controls gave the highest weed biomass values at both 5 and 9 WAT. Weedy check recorded the highest weed biomass.

Table 3 shows the effect of weed management practices on field establishment count of tomatoes. Comparable field establishment counts were observed in all the treated plots. Over 95% field counts were observed in weeded plots irrespective of the management strategy employed. The least establishment count was recorded in the weedy check plots.

The number of fruit count per plant recorded in the manual weeding + Paraquat; Pendimethalin + manual weeding and Pendimethalin + Paraquat were similar and highest in both seasons. Manual weeding at 3 and 7WAT gave similar fruit number with Pendimethalin applied plots. The lowest fruit number per plant was observed in the weedy check plots.

Table 5 shows the effect of weed management practices on the yield of tomato. Fruit yields were highest in either manual weeding, or manual weeding + Paraquat, Pendimethalin + manual weeding, and Pendimethalin + Paraquat. Pendimethalin gave lower fruit yield than the

other weed management practices employed while the least yield was recorded in the weedy check plots.

DISCUSSION

The weed management practices employed in this study proved effective in reducing weed infestation and improved tomato yield. Higher weed density and biomass observed in the Pendimethalin applied plots when compared with other control methods suggested that Pendimethalin could not give season long weed control in tomato production in the study area. This further suggests that a supplementary weed control method would be needed to reduce weed infestation. This was apparent in the lower weed density and weed biomass observed when either manual weeding or Paraquat was employed as supplementary weed management in these trials. It had been observed that pre-transplant herbicide applications do not control germination of late-season weed species (Noling and Gilreath, 2003). The comparable field establishment counts observed in manual weeded and herbicide treated plots was probably an indication that the herbicides used had no phytotoxic effect on tomato plants at the rate of application use in this study. Similar work had reported that Pendimethalin led to slight reduction in seedling emergence and field establishment in okra (Ademiluyi and Arowosegbe, 2010). The present study showed that Pendimethalin did not reduce tomato field establishment. Yields in terms of fruit number per plant and fruit yield (t ha^{-1}) revealed that the highest yield was recorded in the Pendimethalin + Paraquat applied plots which were similar to those of manual weeding; manual weeding + Paraquat, and Pendimethalin + manual weeding. This observation is an indication that the herbicide combinations at the rates used in this study improved weed suppression and subsequently increased yield. It may be concluded from this study that a pre-transplant application of Pendimethalin followed by a supplementary inter-row Paraquat spray will be adequate to manage weed and increase tomato yield. This may replace the labour demanding and expensive manual method of weed management in the study area.

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