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Response of mulching and weed management practices on weed control, yield and economics of garlic

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ABSTRACT

A field experiment was conducted during rainy season of *(Kharif)* 2014 and 2015 at Main Research Station, Hebbal, Bengaluru to know the bio-efficacy of different herbicides against weeds and their effect on growth, yield of garlic and to study the integrated impact of mulching and herbicides on weed growth and to know phytotoxicity effect, if any. The experiment was laid out in a split-plot design with ten treatments, comprising with and without paddy straw mulch 5.0 t/ha in main-plot and weed management methods like pendimethalin at 1.0 kg/ ha, oxyflurofen at 0.22 kg/ha, oxadiargyl at 0.14 kg/ha, manual weeding twice at 20 and 40 DAS and weedy check in sub-plot. Results revealed that among weed management practices, significantly higher bulb yield was obtained in oxadiargyl 0.14 kg/ha (6.6 t/ha in 2014 and 6.2 t/ha in 2015), at par with manual weeding (6.5 t/ha in 2014 and 6.0 t/ha in 2015), due to lower weed density and dry weight resulting in higher net returns and benefit:cost ratio.

Garlic (*Allium sativum* L.) belonging to the family Amaryllidaceae, is the second most widely cultivated crop in this family other than onion. It consists of an underground bulb and above ground vegetative part, which also comprises of a flat as well as slender leaves. It has fibrous root system and is frost hardy. India is the second largest producer of garlic in the world next to China. It is cultivated commercially throughout tropical and subtropical belt of the world. It is one of the important cash crop of India. It is usually grown between the months of October-May, during which the weather is cool and dry that favours its growth and yield. Garlic crop is highly vulnerable to weed infestation due to its slow initial growth, non-branching habit, sparse foliage, shallow root system, frequent irrigation and high fertilizer application. Manual weeding is very difficult due to narrow row spacing of this crop besides non-availability of labour and increased cost involved in it. Yield loss in garlic due to weed competition was upto 94.8% (Anonymous 2009). Sometimes due to shortage of labour and unexpected rains, hand weeding and mechanical operations are more often either delayed or all left together. In such situations, the integrated weed management practice becomes much more important. Therefore, the studies were conducted with and without mulching along with pre-emergence herbicides to provide broad-spectrum weed control and to obtain higher garlic yield.

The field experiment was conducted during rainy season of *(Kharif)* 2014 and 2015 at Main Research Station, Hebbal, Bengaluru to know the bio-efficacy of different herbicides against weeds and their effect on growth and yield of garlic, and to study the integrated impact of mulching on weed growth and phytotoxicity effects. The experiment was laid out in a split-plot design with ten treatments, comprising without paddy straw mulch and paddy straw mulch at 5.0 t/ha in main-plot and weed management methods, *viz*. pre-emergence application of pendimethalin at 1.0 kg/ha, oxyflurofen at 0.22 kg/ha, oxadiargyl at 0.14 kg/ha, manual weeding twice at 20 and 40 DAS and weedy check in sub-plot.

Garlic was planted at a spacing of 15 × 10 cm. The gross plot size was 3 × 3 m. The data on species wise weed count in a quadrate of 50 × 50 cm were collected at 75 DAP (days after planting). From this, density of major weed species/m^2 (sedge, grasses and broad-leaf weeds) was worked out. The, dry weight of weeds' category- sedge, grasses and broad-leaf weeds (g/m^2) was also collected at 75 DAP. The data on weed density and dry weight were analyzed using transformation of square root of $(\sqrt{x+1})$ and log of $(\sqrt{x+2})$, depending on the variability. At harvest, the data on bulb yield, the economics of weed management practices were also worked out. The

data collected on different traits was statistically analyzed using the standard procedure and the results were tested at five per cent level of significance as given by Gomez and Gomez (1984).

Weed flora

Major weed flora observed in the experimental plots were *Cyperus rotundus,* (among sedges), *Echinochloa crus-galli, Cynodon dactylon* (among grasses), whereas, among broad-leaf weeds, *Ageratum conyzoides, , Acanthospermum hispidum, Borreria articularis, Euphorbia hirta* and *Spilanthus acmella* were major weeds at 75 DAP. Among the weed species, the density of *E. crus-galli* and *S. acmella* were higher than other weed species, indicating their dominance from the beginning of the crop cycle in both the years.

Weed density (no./m^2) and dry weight (g/m^2)

At 75 DAP, the herbicides treatments were significantly superior as compared to weedy check with regards to weed density and dry weight. In weedy check the density of broad leaf weeds was higher followed by grasses and sedges at 75 DAP in 2014 and 2015 (**Table 1** and **2**). Hand weeding treatment recorded significantly lower weed density and weed dry weight compared to other treatments. Among the weed management treatments pre-emergence spraying of oxadiargyl at 0.14 kg/ha recorded the lower weed density and weed dry weight compared to other treatments in both the years, indicating the necessity of herbicides to manage complex weed flora in garlic. Interaction of the treatments was found non-significant. These findings are in conformity to Rahman *et al.* (2012) in garlic, Hussain *et al.* (2008) and Patel *et al.* (2011) in onion.

Phytotoxicity

None of the herbicides caused phyto-toxicity to garlic in terms of yellowing, curling, epinasty, hyponasty and wilting symptoms during both the years.

Bulb yield and weed control efficiency

Among herbicides, significantly higher bulb yield was obtained in oxadiargyl 0.14 kg/ha (6.6 t/ha in 2014 and 6.2 t/ha in 2015), which were on a par with manual weeding (6.5 t/ha in 2014 and 6.0 t/ha in 2015) as a result of more number of bulbils, bulb weight and reduced weed density and dry weight as reflected on the bulb yield **Table 3**. The bulb yield (1.1

Table 1. Effect of integrated weed management on weed density and weed dry weight in garlic at 75 DAP during 2014

Treatment	Weed density (no./m^2)				Weed dry weight (g/m^2)			
	Sedges+	Grasses+	BLW#	Total#	Sedge +	Grasses+	BLW#	Total#
Without paddy straw mulch	2.7(6.8)	3.6(12.7)	1.5(30.3)	1.7(49.8)	1.9(3.0)	2.6(5.0)	1.1(12.5)	1.3(20.5)
With paddy straw mulch 5.0 t/ha	2.7(6.8)	3.4(11.3)	1.4(29.0)	1.7(47.0)	1.9(3.0)	2.4(4.3)	1.0(11.0)	1.2(18.2)
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	0.04	NS
Pendimethalin 1.0 kg/ha pre-emergence	2.9(7.7)	3.5(11.3)	1.5(31.6)	1.8(50.6)	2.1(3.4)	2.5(4.3)	1.1(11.5)	1.3(19.3)
Oxyflurofen 0.223 kg/ha pre-emergence	2.7(6.5)	3.8(13.5)	1.5(31.6)	1.8(51.6)	1.9(2.9)	2.6(4.8)	1.1(10.8)	1.3(18.5)
Oxadiargyl 0.14 kg/ha pre-emergence	2.3(4.9)	3.1(8.4)	1.4(21.8)	1.6(35.1)	1.6(1.6)	2.1(2.3)	1.0(8.0)	1.1(11.9)
Twice manual weeding at 20 and 40 DAS	1.9(3.0)	2.7(6.2)	1.2(14.3)	1.4(23.4)	1.3(0.5)	1.8(0.8)	0.7(2.2)	0.9(3.5)
Weedy check	3.6(12.0)	4.6(20.7)	1.7(48.8)	1.9(81.4)	2.7(6.3)	3.5(10.4)	1.4(25.2)	1.6(41.9)
LSD (p=0.05)	0.8	0.7	0.17	0.14	0.5	0.4	0.15	0.13

Data analysed using transformation, # = log ($\sqrt{x+2}$), + = square root ($\sqrt{x+1}$), values within the parentheses are original values
BLW = Broad-leaf weeds, DAS = Days after sowing

Table 2. Effect of integrated weed management on weed density and weed dry weight in garlic at 75-DAP during 2015

Treatment	Weed density (no./m^2)				Weed dry weight (g/m^2)			
	Sedges+	Grasses+	BLW#	Total#	Sedge +	Grasses+	BLW#	Total#
Without paddy straw mulch	3.0(8.5)	3.8(14.7)	1.5(40.1)	1.8(63.4)	2.2(4.5)	2.8(6.7)	1.2(19.0)	1.4(30.2)
With paddy straw mulch 5.0 t/ha	2.9(8.2)	3.8(14.2)	1.5(38.9)	1.7(61.3)	2.2(4.2)	2.8(6.3)	1.2(18.3)	1.4(28.8)
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Pendimethalin1.0 kg/ha pre-emergence	3.2(9.5)	3.4(12.0)	1.6(44.6)	1.8(66.1)	2.4(5.0)	2.6(5.1)	1.3(19.6)	1.5(29.7)
Oxyflurofen 0.223 kg/ha pre-emergence	2.9(7.9)	4.3(18.0)	1.6(39.0)	1.8(64.8)	2.1(3.6)	3.0(7.1)	1.2(16.6)	1.4(27.3)
Oxadiargyl 0.14 kg/ha pre-emergence	2.5(5.5)	3.4(10.5)	1.4(30.3)	1.7(46.3)	1.8(2.4)	2.4(3.7)	1.1(11.1)	1.3(17.2)
Twice manual weeding at20 and 40 DAS	2.2(4.0)	3.1(8.6)	1.2(17.0)	1.5(29.6)	1.5(1.4)	2.1(2.6)	0.8(4.8)	1.0(8.8)
Weedy check	4.0(15.0)	4.9(23.4)	1.8(66.8)	2.0(105.2)	3.2(9.2)	4.0(14.0)	1.6(41.1)	1.8(64.3)
LSD (p=0.05)	0.7	0.9	0.3	0.2	0.5	0.5	0.3	0.2

Data analyzed using transformation, # = log ($\sqrt{x+2}$), + = square root ($\sqrt{x+1}$), values within the parentheses are original values
BLW = Broad-leaf weeds

Table 3. Effect of integrated weed management on bulb yield and weed control efficiency of garlic during 2014 and 2015

Treatments	10 bulb weight (g)		No. of bulbils/plant		Bulb yield (t/ha)		WCE (%)	
	2014	2015	2014	2015	2014	2015	2014	2015
Without paddy straw mulch	44.5	42.1	6.1	5.7	5.3	4.8	-	-
With paddy straw mulch 5.0 t/ha	45.8	43.1	6.5	6.0	5.4	4.8	-	-
LSD (p=0.05)	NS	NS	NS	0.2	NS	NS		
Pendimethalin 1.0 kg/ha pre-emergence	48.0	43.4	5.8	4.8	6.1	5.5	54.1	53.9
Oxyflurofen 0.223 kg/ha pre-emergence	48.7	46.7	6.3	5.8	6.3	5.7	55.8	57.5
Oxadiargyl 0.14 kg/ha pre-emergence	53.3	51.5	7.8	7.8	6.6	6.2	71.5	73.2
Twice manual weeding at 20 and 40 DAS	51.8	49.3	7.2	7.0	6.5	6.0	91.8	86.3
Weedy check	24.0	22.2	4.5	3.9	1.1	0.6	0.0	0.0
LSD (p=0.05)	7.2	1.5	1.4	0.2	0.3	0.6	NA	NA

Cost of herbicides: pendimethalin 30 EC – ` 450/700 ml; oxadiargyl 80 WP – ` 248/35 g; oxyflurofen – 570/100 ml; herbicide application cost - ` 500/ha. Garlic selling price – ` 35/kg of bulbils.

Table 4. Economics of integrated weed management in garlic

Treatment	Net returns (x10^3 `/ha)		B:C ratio	
	2014	2015	2014	2015
Without straw mulch + pendimethalin at 1.0 kg/ha pre-emergence	161.65	141.53	4.2	3.8
Without straw mulch + oxyflurofen at 0.223 kg/ha pre-emergence	162.21	149.83	4.2	3.9
Without straw mulch + oxadiargyl at 0.14 kg/ha pre-emergence	176.86	164.88	4.4	4.2
Without straw mulch + two manual weeding at 20 and 40 DAP	170.83	154.36	4.1	3.8
Without straw mulch + weedy check	-9.43	-26.51	0.8	0.4
With straw mulch + pendimethalin at 1.0 kg /ha pre-emergence	167.45	141.59	4.3	3.8
With straw mulch + oxyflurofen at 0.223 kg /hapre-emergence	173.26	147.72	4.4	3.9
With straw mulch + oxadiargyl at 0.14 kg /ha pre-emergence	181.18	169.12	4.5	4.3
With straw mulch + two manual weeding at 20 and 40 DAP	170.87	154.77	4.0	3.7
With straw mulch + weedy check	-11.15	-25.54	0.8	0.5

t/ha and 0.6 t/ha during 2014 and 2015 respectively,) was very low in weedy check. Use of straw mulch had no significant influence on the bulb yield. The interaction of straw mulch and weed management practices was also non-significant. Similar trend of results was obtained in weed control efficiency.These results are in accordance with Prakash *et al*. (2000) and Vermani *et al*. (2001).

Economics

Use of herbicides was cheaper than hand weeding. Higher B:C ratio was obtained in oxadiargyl 0.14 kg/ha with and without rice straw mulch (4.5 and 4.4 in 2015 and 4.3 and 4.2 in 2015). Whereas, lower B:C ratio was obtained in weedy check (0.8 in 2014 and 0.5 in 2015). This result was obtained due to effective weed management at critical stages by integration of effective pre-emergence herbicides along with mulching which resulted in higher bulb yield with reduced cost of cultivation **Table 4**. Similar findings have been also reported by Vermani *et al*. (2001).

It was concluded that oxadiargyl at 0.14 kg/ha effectively controlled the weeds and produced significantly higher bulb yield and fetched higher B:C ratio.

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