Indian Journal of Weed Science **49**(3): 266–268, 2017
DOI: 10.5958/0974-8164.2017.00069.7

Integrated weed management in garlic

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Received: 19 August 2017; Revised: 12 September 2017

ABSTRACT

A field experiment was conducted during, winter seasons 2014-15 and 2015-16 to evaluate the weed management practices in garlic. The experiment was conducted in a split plot design having straw mulch treatments in main plot (0, 5 t/ha and 10 t/ha) and weed control treatment, *viz*. pendimethalin 1.0 kg/ha (pre-emergence), oxyfluorfen 0.223 kg/ha (pre-emergence) manual weeding (2) and weedy check. Application of mulch at 10 t/ha declined the weed population and recorded significantly lower weed density and higher weed control efficiency (71.65 and 75.17%), and higher growth and yield (2.08 and 2.72 t/ha) of garlic as compared to without mulch treatment. Among the weed control measures, application of oxyfluorfen 0.223 kg/ha recorded significantly lower weed density (55.9 and 70.89 m^2) and higher growth and yield (2.05 and 2.53 t/ha) of garlic as compared to weedy check, but it was at par with pendimethalin 1.0 kg/ha application. Maximum BCR (1.19 and 2.18) was recorded under the paddy straw mulch applied at 10 t/ha and oxyfluorfen 0.223 kg/ha (1.11 and 2.14) as pre-emergence application.

Key words: Garlic, Herbicide, Straw mulch, Weed management

Garlic (*Alleum sativum* L.) is the second widely used cultivated crop after onion. India ranks second after China with respect to area and production of garlic in the world. In India, it is grown on 2.42 lakh hectares of area producing 12.28 lakh tonnes of garlic with the productivity of 5.07 t/ha (Annonymous 2015). In India, major garlic growing states are Madhya Pradesh, Gujarat, Rajasthan and Odhisa. Through the export of garlic and its products, India earns about ` 374.2 million annually (Annonymous 2015). There are certain production constraints in garlic due to which yield levels are poor. Among them, weed problem is very severe in the garlic. Besides this, garlic being non-branching habit, sparse foliage and shallow root system also become vulnarable for weeds. Garlic is a closely planted crop, manual weeding is tedious, expensive and often damages the plants. Thus, all these situations make it necessary on straw mulch and hebicides for an effective and timely control of weed in Garlic. Hence, efficacy of new herbicides needs to be tested. Information on integratred weed management methods in garlic in the agro-climatic conditions of Eastern Uttar Pradesh (India) is meagre. Hence, the present investigation was undertaken to identify effective integrated weed management options in garlic.

MATERIALS AND METHODS

The field experiment was conducted during winter seasons 2014-15 and 2015-16 at Agronomy Research Farm of Narendra Dev University of Agriculture and Technology Kumarganj, Faizabad (UP). The soil of the experimental field was silty loam having pH 8.1, EC 0.23 dS/m, organic carbon 3.2 g/kg, available N 122 kg/ha, available P 16.2 kg/ha and abailable K 251.5 kg/ha respectively. The experiment was laid out in split-plot design and replicated thrice. In main plot mulches were placed, *viz*. without mulch, straw mulch 5 t/ha and straw mulch 10 t/ha. In sub-plot, weed management practices were imposed *viz*. pendimethalin 1.0 kg/ha pre-emergence (PE), oxyfluorfen 0.223 kg/ha PE, twice manual weeding (2) and weedy check. Garlic variety '*Yamuna Safed-1*' was planted on 6 October 2014 and 10 October 2015. The corp was fertilized with 125 kg/ha N, 60 kg/ha P and 60 kg/ha K through urea, single supper phosphate and murate of potash, respectively. Herbicides were sprayed using water 375 L/ha with a knapsack sprayer fitted with a flat fan nozzle. In case of manual weeding, weeds were removed manually with the help of a tools. In case of weedy check weeds were allowed during the whole crop growing season. Data on weed species, growth and yield attribute of garlic were also recorded.

RESULTS AND DISCUSSION

Effect on weed flora

The major weeds noted in the experimental field at 75 days after transplanting (DAT) in the weedy check plot consisted of different categories of weeds. *Chenopodium album, Solanum nigrum, Melilotus alba, Anagallis arvensis* and *Convolvulus arvensis*

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were of broad-leaved weeds (BLWs), while *Cynodon dactylon* and *Phalaris minor* were grassy weeds and *Cyperus rotundus* was only sedges. (**Table 1**). During 1st and 2nd year, the lowest broad-leaf weeds (2.27 and 5.19 no./m^2, respectively), grassy weeds (1.35 and 4.60 no./m^2, respectively) and sedges (31.50 and 53.25 no./m^2, respectively) were recorded under paddy straw at 10 t/ha treated plots.

Paddy straw mulch at 10 t/ha reduced the weed density and dry weight significantly over rest of the treatments. This might be due to effective control of the weeds under treatments (**Table 1**). However, the weed density and dry weight per unit area remained less as compared to other methods tested. Similar finding was also corroborated by Singh and Nandlal (2002). Weed control efficiency was affected substantially due to different mulch treatments. The highest weed control efficiency was recorded in 10 t/ ha mulch treatment (71.65 and 75.17% during 1st and 2nd year, respectively) and lowest was found with no mulch (52.47 and 53.64% during 1st and 2nd year, respectively) during study. In mulch plots, soil was undisturbed nearby garlic plants; hence the weed seeds present in the soil did not get suitable condition for germination and resulted the highest weed control efficiency as compared to no mulched plots. Both the herbicides decreased the number of weeds, weed density and weed dry weight significantly over weedy check (**Table 1**). Oxyfluorfen 0.223 kg/ha as PE proved more effective in reducing weed density and weed dry weight as compared to pendimethalin (1.0 kg/ha as PE). This is mainly due to the fact that oxyfluorfen controlled the all group of weeds very effectively as compared to pendimethalin. Weed control efficiency was also observed better under oxyfluorfen. The results were in agreement with the finding of Vora and Mehta (1998).

Effect on crop

Highest plant height was recorded with the application of 10 t/ha paddy straw mulch at 75 DAP, which was significantly superior over others. Weed control treatments influenced the plant height significantly over weedy check. Both the herbicides (oxyfluorfen at 0.235 kg/ha and pendimethalin at 1.0 kg/ha) and twice hand weeding were at par and recorded taller plants as compare to weedy check during both the years (**Table 2**) . The taller plants in these might be due to less crop weed competition for light, nutrients and moisture during the crop growth period. Plant height was also affected mainly due to crop – weed competition and moisture conservation. These parameters become possible where a combination of paddy straw mulch along with herbicides was used (Rahman *et al*. 2012).

Effect on yield attributes

Reproductive parameters are the resultant of better vegetative development with the commencement of reproductive phase. The yield attributes like fresh weight, dry weight of bulbs and diameter of bulb (cm) were affected largely from the quantum of growth taken place before the reproductive phase consisting of various yield attributing factors. Thus, the reproductive phase was one of the major factors which governed the bulb yield. The relative contribution of these characters in respect of yield is necessary to assess in the light of treatments effect. All yield attributing characters fresh weight of bulb, dry weight of bulb, 100 cloves weight and bulb dry matter indicates that the mulch at 10 t/ha significantly increased the yield attributes over 5 t/ha and no mulch (**Table 2**).

The yield attributes were affected significantly due to application of different weed management

Table 1. Effect of mulches and weed management practices on weed density, weed dry weight and weed control efficiency at 75 Day after planting (DAP) in garlic

Treatment	Broad-leaves weeds (no./m^2)		Grassy weeds (no./m^2)		Sedges (no./m^2)		Weed density (no./ m^2)		Total dry weight (g/m^2)		WCE (%)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Mulche	5.53	13.52	4.12	9.62	39.90	68.71	49.55	91.85	77.73	132.12	52.47	53.64
Without mulch												
Paddy straw mulch 5 t/ha	3.36	9.60	2.78	6.61	35.42	57.42	41.56	73.63	52.90	73.75	67.65	74.12
Paddy straw mulch 10 t/ha	2.27	5.19	1.35	4.60	31.50	53.25	35.12	63.06	46.35	70.75	71.65	75.17
LSD (p=0.05)	0.85	1.88	0.63	1.00	1.22	1.64	1.98	1.54	2.65	2.74	-	-
Weed management												
Pendimethalin 1.0 kg/ha PE	5.20	10.05	3.60	6.66	51.00	61.05	59.80	77.76	71.20	80.50	56.46	71.75
Oxyfluorfen 0.223 kg/ha PE	4.33	8.36	3.07	6.53	48.50	56.00	55.90	70.89	65.30	74.00	60.06	74.03
Manual weeding (two)	2.34	7.26	1.53	5.68	30.45	53.50	34.32	66.44	42.34	67.66	74.11	76.25
Weedy check	12.23	12.06	9.28	8.90	68.35	68.63	89.86	89.59	163.54	146.66	-	-
LSD (p=0.05)	2.37	3.06	2.07	2.49	4.62	3.38	0.68	2.97	4.72	4.78	-	-

Table 2. Effect of mulches and weed management practices on growth, yield attributes and yield of garlic

Treatment	Plant height (cm) 75 DAT		Fresh weight of bulb (g)		Dry weight of bulb (g)		100-cloves weight (g)		Bulb diameter (cm)		Yield (t/ha)		B:C Ratio	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Mulche														
Without mulch	42.27	60.95	6.82	6.30	4.98	5.40	35.82	48.23	1.77	1.92	1.66	1.901	0.96	1.36
Paddy straw mulch 5.0 t/ha	44.31	62.70	6.92	7.62	5.81	6.20	36.14	49.30	1.87	2.37	1.94	2.23	1.10	1.69
Paddy straw mulch 10t/ha	48.35	66.67	9.2	8.62	6.12	7.00	38.07	51.50	1.98	3.00	2.08	2.72	1.19	2.18
LSD (p=0.05)	2.40	2.49	1.30	2.91	2.53	0.94	4.61	2.40	0.66	0.78	0.28	0.15	-	-
Weed management														
Pendimethalin 1.0 kg/ha PE	41.51	66.13	7.63	9.00	7.37	6.70	33.33	54.20	2.67	2.43	2.02	2.46	1.09	1.97
Oxyfluorfen 0.223 kg/ha PE	42.48	66.56	8.18	10.13	7.67	6.95	33.67	54.64	2.77	2.26	2.05	2.53	1.16	2.14
Manual weeding (two)	47.00	67.20	9.05	10.73	8.10	6.23	35.53	55.80	3.10	2.50	2.13	2.59	1.11	1.92
Weedy check	42.00	53.06	5.76	4.47	3.95	3.96	32.25	33.00	1.56	1.96	1.34	1.56	0.97	0.94
LSD (p=0.05)	4.50	2.77	1.43	1.83	1.59	1.94	4.56	4.84	1.01	1.31	0.40	0.23	-	-

treatments. The number of bulb/m^2 and diameter of bulb (cm) were recorded significantly higher under mulch with 10 t/ha + oxyfluorfen (0.223 kg/ha) followed by pendimethalin (1.0 kg/ha) and hand weeding twice (45 and 75 DAP) each combined with 10 t/ha paddy straw mulch over weedy check. It might be due to the fact that all the growth characters remained higher, where 10 t/ha mulch + oxyfluorfen (0.223 kg/ha) was applied. These results were also confirmed by Lawande *et al*. 2009.

The bulb weight (fresh and dry) was affected significantly due to different weed control and mulch as it was directly related to the crop-weed competition. However, highest bulb weight was recorded with 10 t/ha mulch over rest of the treatments. Among herbicide treatments, the highest bulb was recorded under 10 t/ha mulch + oxyfluorfen followed by 10 t/ha mulch + pendimethalin and 10 t/ha mulch + twice hand weeding although difference were non-significant (Singh and Nandlal 2002).

Effect on bulb yield

The significantly higher bulb yield was recorded under 10 t/ha paddy straw mulch followed by 5 t/ha and no mulch (**Table 2**). Similarly, different weed control measures influenced the bulb yield significantly. Oxyfluorfen (0.223 kg/ha), hand weeding (45 and 75 DAP) and pendimethalin (1.0 kg/ha) along with 10 t/ha paddy straw mulch combination being at par recorded significantly higher value of bulb weight as compared to weedy check treatments. However, weedy check caused the significantly lower bulb dry weight as compare to all three treatments. This might have effectively controlled the weeds during the crop growth period especially at critical crop growth stages resulting in production of higher bulb dry matter, bulb weight and bulb diameter, which might have contributed to higher bulb yields. These results were also confirmed by Kumar *et al*. (2013). The highest benefit cost ratio (1.19 and 2.18 in 2014 and 2015, respectively) were obtained with 10 t/ha straw mulch whereas under weed management practices highest benefit cost ratio (1.16 and 2.14 in 2014 and 2015, respectively) with oxyfluorfen 0.223 kg/ha treatment.

It was concluded that oxyflurofen 0.223 kg/ha and pendimethalin 1.0 kg/ha integrated with 10 t/ha rice straw mulch being at par and recorded significantly higher garlic yield and effective control of complex weed flora.

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