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Chemical weed management in garlic

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ABSTRACT

A field experiment was conducted to study the influence of various herbicidal treatments on the growth and productivity of garlic (*Allium sativum* L.) during 2012-13 and 2013-14 on sandy loam soils of SKUAST, Chatha. The experiment involved two genotypes of garlic replicated thrice in factorial randomized block design. The weed density, weed dry matter accumulation and weed control efficiency varied significantly with the stage of the crop showing a declining trend, being highest at 60 days after sowing and lowest at the time of harvesting. Significantly lower weed density, weed dry matter accumulation, weed index and relatively higher weed control efficiency were recorded in large segmented cultivar (*SJKG-01*) with weed free plots followed by treatment with pre-emergence application of oxadiargyl 90 g/ha *fb* post-emergence application of quizalofop-ethyl 50 g/ha, at 2-3 leaf stage of weeds. The average bulb weight (26.73 g), bulb diameter (3.96 cm.) and bulb yield (4.83 t/ha) were also more in large segemented than the smaller one (*SJKG-02*). Among herbicidal treatments, the weed free plots in both the cultivars produced plants with more average bulb weight, bulb diameter and bulb yield followed by the plots with pre-emergence application of oxadiargyl *fb* post-emergence application of quizalofop-ethyl, applied at 2-3 leaf stage of the weeds. From economics point of view, the weed free plots resulted in higher cost of cultivation and net returns followed by the treatment combination of oxadiargyl 90 g/ha pre-emergence *fb* quizalofop-ethyl as post-emergence 50 g/ha applied at 2-3 leaf stage of weeds yielding a B: C ratio of 5.70 in small segmented and 6.73 in large segmented garlic respectively.

Key words: Chemical control, Garlic, Herbicides, Quizalofop-ethyl, Weed management

Garlic (*Allium sativum* L.) belonging to family amaryllidaceae, is the second most widely cultivated crop in the family after 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 second largest producer of garlic in the world next to China. Madhya Pradesh is front runner in its production followed by Gujrat. Jammu & Kashmir occupied an area of 0.28 thousand hectare with a production of 0.30 thousand MT (Anonymous, 2011). In Jammu division, it is a prominent crop of the districts of Poonch, Kathua, Udhampur, Reasi and Doda. But its productivity in the state is quite less as compared to the national average due to a number of factors but the main limiting factor is the weed infestation that competes for nutrients, soil, moisture, space and light considerably reducing the yield, quality and value through increased production and harvesting costs (Hussain 1983). The garlic is closely planted crop with very small canopy. Due to smaller leaf size it can not compete with the weeds. Their competition with the plants starts at very early growth stage because immediately after planting the cloves, the weed emergence occurs that competes with the tender seedlings. Under Jammu and Kashmir conditions, weeds are mostly managed manually, which is tedious and expensive operation and often damages the crop,

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 herbicidal weed management practices becomes much more important. Therefore, the studies were conducted to test old and new herbicides used either alone or in combination at different times to provide good results of weed control, and garlic yield.

MATERIALS AND METHODS

Field experiment was conducted during *Rabi* 2012-13 and 2013-14 at Chatha, Jammu (32-40^0 N latitude, 74-53^0 E longitude and 300 m. above mean sea level). The soil of the experimental site was silty loam in texture, slightly alkaline in reaction (pH 7.72), medium in available N (240 kg/ha) and P_2O_5 (12.1 kg/ha) and low in available K_2O (134 kg/ha). Twelve treatments comprised of pre-plant, pre-emergence (2 DAS) and post- emergence (30 DAS) application of oxyflourofen 0.15 kg/ha, pre-emergence application

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of pendimethalin 1.0 kg/ha, alachlor 1.5 kg/ha and butachlor 1.0 kg/ha, early-post (10 DAS) application of oxadiargyl 120 g/ha, pre-emergence application of oxadiargyl 90 g/ha *fb* post-emergence (2-3 leaf stage of weeds) application of ouizalofop-ethyl 50 g/ha, pre-emergence application of pendimethalin 0.75 kg/ha *fb* post-emergence application quizalofop-ethyl 50 g/ha, two hand weedings (40 and 60 DAS), weedy check and weed free, respectively.

A basal dose of farm yard manures 20 t/ha was incorporated in the soil at the time of field preparation. In addition to this 100 kg N, 50 kg P_2O_5 and 50 kg K_2O per hectare were applied through urea, single super phosphate and muriate of potash, respectively. The full dose of phosphorus, potash and 1/3 of nitrogen was applied at the time of sowing and the remaining nitrogen was applied 40 and 60 days after planting. Both large segmented (*SJKG-1*) and small segmented (*SJKG-2*) were dibbled at a spacing of 15 x 10 cm and 5-7.5 cm deep using a seed rate of 600 kg/ha. The herbicides were sprayed to each treatment plot using knapsack sprayer with a spray volume of 600 L water/ha. Rest of the management practices were in accordance with the recommended package of practices.

The survey of weed flora of the experimental plot was done at 60 days after planting and at the time of harvesting. For recording the observations, five plants were randomly selected in each plot and tagged. The observations were recorded from time to time. The data obtained on various parameters were analyzed as per fisher's method (Cochran and Cox 1957). The treatment differences were tested for significance by 'F' test for the data in which the treatment effects were significant, the appropriate standard error of mean and critical differences were worked out at 5% level of significance.

RESULTS AND DISCUSSION

Weed flora

Garlic crop was infested with a large number of weeds owing to longer duration, slow initial growth, non tillering/branching habit and sparce canopy development besides frequent irrigation and high fertilizer application. Prominent weed species recorded were *Chenopodium album*, *Chenopodium murale*, *Amaranthus viridis*, *Anagallis arvensis*, *Convolvulus arvensis*, *Parthenium hysterophorus*, *Spergula arvensis*, *Digera arvensis*, *Cyprus rotundus*, *Euphorbia hirta* and *Cynodon dactylon*. The pooled data of two years indicated that both the varieties varied significantly for the weed density, recorded a 60 DAS and at harvest. Large segmented cultivar (*SJKG-1*) possessed less weed density (51.36 and 46.44/m^2) than the smaller one (53.06 and 48.06) during both the years under study (Table 1). Wider leaf blade and drooping habit of *SJKG-1* might havesuppressed the weed infestation during whole crop cycle.

In both cultivars, weed free plots possessed no weed density followed by treatment plots with pre-emergence application of oxadiargyl 90 g/ha+ post-emergence application of quizalofop-ethyl 50 g/ha. The treatments oxyflurofen 0.15 kg/ha (PE) was statistically at par with oxyflurofen 0.15 kg/ha (pre-plant) and pendimethalin 1.0 kg/ha (PE) recorded 60 DAS. Weed dry matter accumulation was least in weed free plots followed by treatment plots with pre-emergence application of oxadiargyl 90 g/ha + post-emergence application of quizalofop-ethyl 50 g/ha recorded at 60 DAS and at harvesting, during both the years. However, dry matter accumulation 60 DAS in treatment with post emergence application of oxyflurofen, early post application of oxadiargyl and two hand weeding at 40 and 60 DAS was at par (Table 1). Weed control efficiency denotes the magnitude of increase in yield due to weed control. Both cultivars (*SJKG-1* and *SJKG-2*) varied in terms of weed control efficiency both at 60 DAS and at harvesting.

Larger segmented yielded more WCE (66.16% and 59.28%) than the smaller one (64.25% and 58.65%). The weed free plots with 100% WCE were followed by plots having treatment with pre-emergence application of oxadiargyl 90 g/ha + post-emergence application of quizalofop-ethyl 50 g/ha and plots receiving 2 hand weedings (40 and 60 DAS). Lowest WCE was recorded in weedy check plots. Both types of garlic responded variably towards the weed index, during both the years (Table 2). Large segmented recorded significantly lower weed index (27.14) then the smaller one (30.44). Herbicides were also significant in influencing the weed index and lower weed index (9.83%) was recorded with pre-emergence application of oxadiargyl 90 g/ha + post-emergence application of quizalofop-ethyl 50 g/ha applied at 2-3 leaf stage of weeds followed by two hand weedings (40 and 60 DAS). Treatments comprising of pre-emergence and post–emergence application of oxyflurofen 0.15 kg/ha were at par to each other during both the years. This parameter was maximum in weedy check plots due to prominent weed-crop competition, suppression of crop plants by the emerging weeds and more utilization of nutrients and moisture by the weed canopy. Similarly, maximum weed index was recorded by Rahman *et al.* (2012) in garlic, Hussain *et al.* (2008) and Patel *et al.* (2011) in onion. The chemical weed control in garlic is a better practice supplemented to

Table 1. Effect of herbicidal treatments on weed density, weed dry matter accumulation and weed control efficiency (pooled data of two years)

Treatment	Weed density (no./m^2)				Weed dry matter accumulation (%)				WCE (%)			
	60 DAS		At harvest		60 DAS		At harvest		60 DAS		At harvesting	
	SJKG-1	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*
Oxyflurofen 0.15 kg/ha PP	50.0	53.0	42.0	47.0	69.7	82.6	30.7	34.1	73.3	75.0	66.7	64.8
Oxyflurofen 0.15kg/ha PE (2 DAS)	41.7	59.0	33.7	53.0	75.5	80.3	42.5	35.4	66.9	66.2	54.8	56.5
Oxyflurofen 0.15kg/ha POE (30 DAS)	38.0	39.7	30.0	31.7	52.5	74.8	28.4	31.5	68.0	67.3	56.2	60.1
Pendimethalin 1.0 kg/ha PE	54.0	50.3	46.0	44.3	71.6	80.5	34.7	37.9	54.4	53.7	55.6	53.6
Alachlor 1.5kg/ha PE	51.0	78.0	47.0	74.0	78.4	84.0	41.3	39.4	52.6	48.3	45.9	49.7
Butachlor 1.0 kg/ha PE	68.0	75.0	64.0	71.0	73.0	82.2	30.1	36.7	48.6	40.8	43.1	46.9
Oxadiargyl 120g/ha E- Post (10 DAS)	65.0	58.0	54.0	50.0	69.6	75.3	28.2	30.6	79.6	78.0	71.5	68.8
Oxadiargyl 90 g/ha PE *fb* quizalofop-ethyl 50 g/ha POE	34.3	31.0	28.3	25.0	39.3	59.3	25.5	27.0	87.6	88.7	76.6	73.9
Pendimethalin 0.75kg/ha PE *fb* quizalofop-ethyl 50 g/ha POE	69.7	64.0	63.7	56.0	47.0	67.2	32.8	35.1	68.1	68.5	67.4	60.1
Two HW 40 and 60 DAS	59.7	53.3	53.7	45.3	50.6	76.9	26.2	29.7	83.8	84.4	73.5	69.1
Weedy check	85.0	75.3	90.0	79.3	85.6	84.6	53.7	49.7	0.00	0.0	0.00	0.0
Weed free	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0
Pooled Mean	51.4	53.1	46.4	48.1	59.4	70.6	31.2	32.3	66.2	64.2	59.3	58.6
LSD (P=0.05) Varietie	1.24		1.24		5.15		0.88		0.49		0.52	
Herbicide	3.03		3.03		12.61		2.15		1.19		1.28	
Varieties x herbicide	4.30		4.29		17.83		3.04		1.69		1.81	

Table 2. Effect of herbicidal treatments on weed index, average bulb weight, bulb diameter, bulb yield/plot and total bulb yield (pooled data for two years)

Treatment	Weed index		Avg. Bulb weight (g)		Bulb diameter (cm)		Bulb yield/plot (g)		Total bulb yield (t/ha)	
	SJKG-1	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*
Oxyflurofen 0.15 kg/ha PP	23.9	28.3	25.9	21.8	4.01	3.42	2269.6	1911.3	5.04	4.25
Oxyflurofen 0.15kg/ha PE (2 DAS)	38.5	40.7	20.3	21.7	3.75	3.27	1852.3	1580.9	4.12	3.51
Oxyflurofen 0.15kg/ha POE (30 DAS)	37.3	42.1	26.4	18.1	3.86	3.78	1869.0	1542.5	4.15	3.43
Pendimethalin 1.0 kg/ha PE	28.5	34.6	22.9	20.5	3.60	3.31	2130.2	1744.9	4.73	3.88
Alachlor 1.5kg/ha PE	42.6	44.9	24.8	16.7	3.69	3.44	1711.0	1468.4	3.80	3.26
Butachlor 1.0 kg/ha PE	41.2	46.5	28.5	17.1	3.80	3.48	1752.0	1426.2	3.89	3.17
Oxadiargyl 120g/ha E- Post (10 DAS)	22.0	24.6	31.6	22.3	4.02	3.64	2324.5	2010.2	5.17	4.47
Oxadiargyl 90 g/ha PE *fb* quizalofop-ethyl 50 g/ha POE	8.4	11.2	31.7	26.0	4.41	3.87	2729.4	2367.7	6.06	5.26
Pendimethalin 0.75kg/ha PE *fb* quizalofop-ethyl 50 g/ha POE	15.2	18.8	30.1	24.2	4.09	3.29	2526.7	2165.1	5.61	4.81
Two HW 40 and 60 DAS	12.4	14.5	29.4	25.0	4.29	3.70	2611.4	2279.0	5.80	5.06
Weedy check	55.5	58.7	15.0	13.9	3.29	3.05	1326.4	1100.7	2.95	2.45
Weed free	0.0	0.0	33.7	28.4	4.75	3.98	2981.2	2667.1	6.62	5.93
Pooled Mean	27.1	30.4	26.7	21.3	3.96	3.49	2173.2	1855.3	4.83	4.12
LSD (P=0.05) Varieties:	0.4	0.1	1.1	0.4	0.07	0.02	11.9	4.2	0.03	0.009
Herbicides:	1.0	0.4	2.9	1.0	0.17	0.06	29.3	10.3	0.06	0.023
Varieties x Herbicides:	1.5	0.5	4.1	1.4	0.23	0.08	41.5	14.5	0.092	0.032

PP= pre plant, PE= pre-emergence, POE=post-emergence

conventional methods and forms an integral part of the modern crop production practices in this crop. The use of herbicides is one of the options left with the farmers to eliminate crop weed competition at the early growth stages of the crop.

The oxadiargyl acts as contact herbicide whereas the quizalofop-ethyl functions systemically, get translocated into the plant system thus restricting the weed growth and yielding significant weed control efficiency after weed free treatment. The interaction between the varieties also showed similar trend owing to less weed-crop competition, more clean cropped area and interfering with the metabolic pathways of the weeds. The results were in conformity with the findings of Channappagouder and Biradar (2007). Moreover, Ramani and Khanpare (2010), Ramalingam *et al.* (2013) advocated that these herbicides had no residual effects on the succeeding crops of groundnut, green gram and pearl millet.

Yield studies

Both the cultivars (*'SJKG-1'* and *'SJKG-2'*) varied significantly for the yield attributes, *viz.* average bulb weight, bulb diameter, bulb yield per plot and total bulb yield as evident from the pooled data recorded in two years. (Table 2). All these attributes were significantly higher in large segmented (*'SJKG-1'*) than the smaller one (*'SJKG-2'*). Higher bulb weight (26.73 g), bulb diameter (3.96 cm.), bulb yield per plot (2173.21 g) and total bulb yield (4.83 t/ha) in larger segmented cultivar as compared to smaller one (21.34 g, 3.49 cm., 1855.37 g and 4.12 t/ha) owes to more surface area of the leaves and spreading habit that resulted in more absorption of sunlight and more dry matter accumulation and ultimately the total yield. Tindal (1986) also emphasized the importance of capture of space and sunlight for better foliage development leading to more total yields. The herbicidal treatments also significantly influenced these yield parameters being more recorded in weed free plots followed by pre-emergence application of oxadiargyl 90 g/ha *fb* post-emergence application of quizalofop-ethyl 50 g/ha and minimum being recorded in weedy check (Table 2). More yields in weed free plots seems to be due to favourable environment created by clean crop culture resulting in more absorption of solar radiation and plant nutrients resulting in more photosynthetic rates and more dry matter accumulation in the cloves following the cultural practices in weed free plots . The positive herbicidal effects of oxadiargyl and quizalofop-ethyl were disruption of cell division and ionic balance ultimately leading to death of weeds thus created favourable conditions for better crop growth and yield. The weedy check recorded minimum yield attributes owing to low chlorophyll content and photosynthetic rates due to unchecked weed growth thereby reducing the availability of moisture, light and nutrients to the crop and resulted in loss of yield in unweeded control (Channappagouder and Biradar 2007).

Economic studies

Significantly higher gross returns (` 3,64,369) and net returns (` 3,00,436) was realized in large segmented garlic with weed free plots (Table 3), followed by pre-emergence application of oxadiargyl 90 g/ha *fb* post-emergence application of quizalofop-ethyl 50 g/ha applied at 2-3 leaf stage of weeds. This was due

Table 3. Effect of herbicidal treatments on economics of garlic

Treatment	Cost of cultivation (x10^3 ` /ha)	Gross returns (x10^3 `/ha)		Net returns (x10^3 `/ha)		B:C Ratio	
		SJKG-1	*SJKG-2*	*SJKG-1*	*SJKG-2*	*SJKG-1*	*SJKG-2*
Oxyflurofen 0.15 kg/ha PP	44.2	277.4	233.6	233.1	189.3	5.2	4.2
Oxyflurofen 0.15kg/ha PE(2 DAS)	44.2	226.4	193.2	182.1	148.9	4.1	3.3
Oxyflurofen 0.15kg/ha POE (30 DAS)	44.2	226.4	193.2	182.1	148.9	4.1	3.3
Pendimethalin 1.0 kg/ha PE	44.2	260.3	213.2	216.1	169.0	4.8	3.8
Alachlor 1.5kg/ha PE	44.1	209.1	179.4	165.0	135.3	3.7	3.0
Butachlor 1.0 kg/ha PE	42.9	214.1	174.3	171.1	131.3	3.9	3.0
Oxadiargyl 120g/ha ethyl-post (10 DAS)	43.0	284.1	245.6	241.0	202.6	5.6	4.7
Oxadiargyl 90 g/ha PE *fb* quizalofop-ethyl 50 g/ha POE	43.1	333.6	289.3	290.4	246.2	6.7	5.7
Pendimethalin 0.75kg/ha PE *fb* quizalofop-ethyl 50 g/ha POE	44.0	308.8	264.6	264.7	220.5	6.0	5.0
2 HW 40 and 60 DAS	48.9	319.1	278.5	270.2	229.6	5.5	4.7
Weedy check	41.4	162.1	134.5	120.7	931.3	2.9	2.2
Weed free	63.9	364.3	325.9	300.4	262.0	4.7	4.1

to better control of weeds in these treatments. But B: C ratio was significantly higher (6.73) in pre-emergence application of oxadiargyl *fb* post-emergence application of quizalofop-ethyl followed by pre-emergence application of pendimethlin *fb* post-emergence application of quizalofop-ethyl (6.01). This could be attributed to lower cost of cultivation in these treatments as compared to weed free plots. In weed free plots the cost of cultivation increased remarkably due to regular weeding operations followed for clean cultivation. It increased the cost of manual weeding thus corresponding towards total output cost. Moreover, unweeded control recorded significantly lesser B: C ratio (2.92) due to lower bulb yield owing to more crop weed competition. Similar findings were also recorded by Prakash *et al.* (2000) and Vermani *et al.* (2001).

The weed free plots resulted in higher cost of cultivation and net returns followed by the treatment combination of oxadiargyl 90 g/ha (PE) *fb* quizalofop-ethyl (POE) 50 g/ha applied at 2-3 leaf stage of weeds yielding a B: C ratio of 5.70 in small segmented and 6.73 in large segmented garlic respectively.

REFERENCES

Anonymous. 2011. Area, production and productivity of garlic in Jammu and Kashmir (cf: www.nhb.in)

Channappagouder BB and Biradar NR. 2007. Physiological studies on weed control efficiency in direct sown onion (*Allium cepa* L.) *Karnataka Journal of Weed Sciences* **20**(2): 375-376.

Cochran WG and Cox GM. 1957. *Experimental Designs.* 2nd ed. John willey and son's inc. Chapman and hall Ltd. London.

Hussain F.1983. Biochemical inhibition (allelopathy) a less understood ecological factor in agroecosystems. *Progressive Farming* **3**: 33-37.

Hussain Z, Marwat KB, Alishah SI, Arifulla SA and Khan NM. 2008. Evaluation of different herbicides for weed control in onion (*Allium cepa* L.). *Sarhad Journal of Agriculture* **24**(3): 453-456.

Parkash V, Pandey AK, Singh RD and Mani VP 2000. Integrated weed management in winter onion under mid hill conditions of North Western Himalayas. *Indian Journal of Agronomy* **45**(4): 816-825.

Patel TU, Patel CL, Patel DD, Thanki DD, Patel PS and Jat RA. 2011. Effect of weed and fertilizer management on weed control and productivity of onion (*Allium cepa* L.) *Indian Journal of Agronomy* **56**(3): 267-272.

Rahman UH, Khattak AM, Sadiq M, Ullah K, Javeria S and Ullah I. 2012. Influence of different weed managemnt practices on yield of garlic crop. *Sarhad Journal of Agriculture* **28**(2): 213-218.

Ramani BB and Khanpare VD. 2010. Efficacy of various herbicides and determination of their persistence through bioassay technique for garlic (*Allium sativum* L.) *Indian Journal of Weed Science* **42**(3&4): 198-202.

Ramalingam SP, Chinnppagounder C, Perumal M and Palanisamy MA. 2013. Evaluation of new formulation of oxyflurofen (23.5% EC) for weed control efficacy and bulb yield in onion. *American Journal of Plant Sciences* **4**: 890-895.

Tindal HD. 1986. *Vegetables in the tropics.* Macmillan Education limited Hound mills Basing Toke, Hampshire, England, 533p.

Vermani A, Nandal TR and Singh R 2001. Nutrient uptake and economic weed management in garlic (*Allium sativum* L.) *Indian Journal of Weed Science* **33**(3&4): 225-226.