Indian Journal of Weed Science (2024) **56**(2): 186–190
http://dx.doi.org/10.5958/0974-8164.2024.00029.2

RESEARCH ARTICLE

Integrated weed management in onion

Pabitra Adhikary[1*] and Subhra Shil[2]

Received: 1 June 2023 | Revised: 24 May 2024 | Accepted: 27 May 2024

ABSTRACT

Field experiment was conducted at the Instructional Farm of Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia, West Bengal, India during *Rabi* season of 2013-14 and 2014-15 to study the effect of integrated weed management practices on weeds and yield of onion (*Allium cepa* L.). At early stage of crop growth *i.e.* at 10 DAT, maximum weed control efficiency (82.57%) was recorded in the treatment of propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha (tank mix) as pre-emergence followed by aqueous extract of cucumber (*Cucumis sativus* L.) 10% 2.5 liter/ha at 1 DAT (72.83%). Weed control efficiency (WCE) was sustained at later stage with 60.98% and 51.96% in these treatments, respectively. While in the later crop growth phase *i.e.* 25 DAT onwards, two hand weeding at 20 and 40 DAT recorded significantly the lowest weed density, biomass and higher weed control efficiency (83.27, 77.02, 64.23% at 25, 50 and 75 DAT, respectively). Notable increase in growth and yield attributes *viz*., plant height, chlorophyll content, LAI, DMA, CGR, bulb diameter, bulb length, scales/bulb, bulb yield, biological yield and harvest index were recorded in two hand weeding followed by PE application of propaquizafop + oxyfluorfen *fb* mechanical weeding (MW) and cucumber aqueous extract 10% *fb* MW. The net return and B:C ratio was significantly higher with propaquizafop+ oxyfluorfen *fb* MW and cucumber aqueous extract 10% *fb* MW due to lesser cost of herbicides usage compared to hand weeding.

Key words: Allelopathy, Onion, Oxyfluorfen, Propaquizafop, Weed management

INTRODUCTION

Onion (*Allium cepa* L.) is the most important biennial vegetable bulb crop grown throughout the world. In India, it occupies an area of about 1.625 million ha with production of 26.64 million tons and productivity of 16.39 t/ha (Anonymous 2021). West Bengal is an onion growing state with production of 0.863 million tons and average productivity of 19.74 t/ha from an area of 0.044 mha (Anonymous 2021). The area under onion cultivation has been tremendously boosted due to release and availability of high-yielding varieties in the state. Onion crop has poor competitive ability with weeds due to inherent characteristics such as short stature, non-branching habit, shallow root system and extremely slow growth in initial stage, causing significant reduction in yield. Yield loss due to weed infestation is reported to the tune of 50-80% (Kumari *et al*. 2019). Even the losses caused by weeds exceed the losses from any other category of agricultural pests in West Bengal (Adhikary 2018). For attaining the maximum yield, timely and effective weed control during the critical period of weed competition becomes necessary (Adhikary *et al*. 2016). Controlling weeds during early phase of crop growth is essential to obtain high yields and marketable produce. As conventional method of weed control, hand weeding is laborious, time consuming and expensive. Sole application of herbicides does not give an effective weed control. Options are limited for chemical weed management in onion while assuring quality of crop produce and ensuring higher benefit – cost ratio. Hence, it was felt necessary to assess different weed management practices applied alone and in combination for improving growth and yield of onion in alluvial zone of West Bengal.

MATERIALS AND METHODS

Field experiments were conducted in the humid subtropics at the Instructional Farm of Bidhan Chandra Krishi Vishwavidyalaya (BCKV), Mohanpur, Nadia, West Bengal during *Rabi* season of 2013-14 and 2014-15. The experimental site was situated at 22.93°N latitude and 88.53°E longitude with an altitude of 9.75 meters above mean sea level. The

[1] North 24 PGs Krishi Vigyan Kendra, WBUAFS, Ashokenagar, West Bengal 743223, India

[2] Krishi Vigyan Kendra Khowai, Divyodaya, Chebri, Tripura 799207, India

* Corresponding author email: pabitra.bdp@gmail.com

local cultivar of onion '*Sukhsagar*' was used in the study. The experiment was laid out in a randomized complete block design with five treatments and four replications. The treatments were weedy check, two hand weeding (HW) at 20 and 40 days after transplanting (DAT), two mechanical weeding (MW) at 20 and 40 DAT, propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha (tank mix) as pre-emergence (PE) at 1 DAT *fb* MW at 40 DAT, and aqueous extract of cucumber (*Cucumis sativus* L.) with 10% 2.5 liters/ha at 1 DAT *fb* MW at 40 DAT. Aqueous extract was prepared as per the procedure described by Adhikary (2012). The inflorescence, leaves, stems and twigs of cucumber plant species were collected from the Instructional Farm (BCKV). The collected samples were dried in shade at room temperature for a week and later dried at 40°C in oven for 48 hours and ground to prepare the dry powder. Aqueous extract was prepared by using 100 g of dry powder dissolved in 1,000 ml of distilled water for 24 hours to obtain a concentration of 10%. Then it was filtered and the filtrate was boiled at a temperature of 60°C for two hours to concentrate the volume. The final extract was left to stand at 40°C for 30 minutes and then again filtered. The aqueous extract was used for spraying in the specific plots on the next day after mixing with non-ionic surfactant (Tween 80). The chemical herbicides as well as cucumber (*Cucumis sativus* L.) aqueous extract were sprayed with the spray volume of 500 liters/ha using knapsack sprayer fitted with flood jet deflector (WFN040 nozzle). All the other recommended agronomic and need-based plant protection measures were followed. Data on weed density and biomass were recorded at 10, 25, 50 and 75 DAT. Weed control efficiency (WCE) of different treatments was computed on the basis of weed biomass. Plant height, chlorophyll content and LAI were recorded at 75 and 100 DAT where as dry matter accumulation (DMA) and CGR were recorded at 25, 50, 75 and 100 DAT. Yield attributes were recorded at harvest. Data were subjected to statistical analyses following analysis of variance (ANOVA) technique, and mean differences were adjusted by the multiple comparison tests (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect on weeds

Dominant weed species found in the experimental plot were *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Echinochloa colona*, *Eleusine indica*, *Cyperus rotundus*, *Blumea lacera*, *Chenopodium album*, *Cleome viscosa*, *Commelina diffusa*, *Melilotus alba*, *Nasturtium officinale*, *Physalis minima*, *Portulaca oleracea*, *Trianthema portulacastrum* and *Digera arvensis*. Similar findings on weed flora were also observed by Adhikary *et al*. (2014) and Kumari *et al*. (2019).

The pooled data on weed density at different crop growth stages (**Table 1**) revealed an increasing trend with the progress of crop growth in each treatment. Application of propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha at 1 DAT recorded significantly the lowest total weed density (3.13/m^2) at 10 DAT, which was followed by cucumber aqueous extract 10% (4.41/m^2). Among different treatments, minimum weed density (3.10, 4.17 and 6.55 /m^2 at 25, 50 and 75 DAT was recorded in two hand weeding at 20 and 40 DAT, respectively), whereas the weedy check plots recorded the highest total weed density. The chemical herbicide treated plots recorded significantly the lowest weed biomass (5.08 g/m^2) at 10 DAT and was followed by the use of cucumber plant extract 10% concentration 2.5 liters / ha PE when each of these treatments was combined with mechanical weeding. Since cucumber plants are mostly discarded as large waste after crop harvesting, allelopathy of cucumber plants was investigated for possible weed management options.

Table1. Effect of treatments on weed density, weed biomass and weed control efficiency at different growth stages in onion (pooled over two years)

Treatment	Total weed density (no./m^2)				Weed biomass (g/m^2)				Weed control efficiency (%)			
	10 DAT	25 DAT	50 DAT	75 DAT	10 DAT	25 DAT	50 DAT	75 DAT	10 DAT	25 DAT	50 DAT	75 DAT
Weedy check	6.69(43.7)	7.65(58.0)	8.07(64.1)	10.15(102.2)	29.15	59.41	67.44	104.40	0.00	0.00	0.00	0.00
Two HW	6.41(40.1)	3.10(8.9)	4.17(16.9)	6.55(42.5)	25.15	9.94	15.50	37.45	13.72	83.27	77.02	64.13
Two MW	6.54(41.7)	4.51(19.4)	4.94(24.0)	7.91(61.7)	25.56	15.20	22.13	53.21	12.32	74.42	67.19	49.03
Propaquizafop + oxyfluorfen *fb* MW	3.13(8.9)	3.96(14.7)	4.75(21.9)	6.99(48.2)	5.08	13.05	21.01	40.74	82.57	78.03	68.85	60.98
Cucumber aqueous extract 10% *fb* MW	4.41(18.7)	4.97(23.7)	5.00(25.0)	7.51(56.0)	7.92	20.80	22.38	50.15	72.83	64.99	66.81	51.96
LSD (p=0.05)	0.62	0.59	0.74	0.72	4.11	3.16	3.78	3.59	-	-	-	-

*****Original values in parentheses were subjected to square root transformation

Two potent growth inhibitory substances are present in cucumber (*Cucumis sativus* L.) plants. These substances were determined as HMO (9-hydroxy-4,7-megastigmadien-9-one) and THMO (6,9,10-trihydroxy-4,7-megastigmadien-3-one). HMO and THMO have the ability to inhibit the seed germination and growth of different grass species. Similar allelopathy effect of cucumber extract was observed by Noguchi *et al.* (2015). Two hand weeding (20 and 40 DAT) recorded minimum weed biomass of 9.94, 15.50 and 37.45 g/m^2 at 25, 50, 75 DAT, respectively. Weeds along with propagating materials like bulbs and bulb lets (sedges), tap roots (broad-leaved weeds), stolons (grasses), *etc*. could be removed or uprooted by Khurpi - aided hand weeding or mechanical weeder. Among different weed control treatments, application of propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha *fb* MW at 40 DAT recorded the highest weed control efficiency (WCE) of 82.57% at 10 DAT and was followed by PE application of cucumber aqueous extract 10% *fb* MW at 40 DAT (72.83%). This might be due to control of weeds during early growth stage by pre-emergence application of propaquizafop+ oxyfluorfen (tank mix) and cucumber aqueous extract which prevented emergence of monocot and grassy weeds by inhibiting root and shoot growth, while mechanical weeding (MW) at 40 DAT was responsible for controlling of broad-leaved weeds which caused complete destruction of these weeds at 3-4 leaf stage. Two hand weeding registered maximum weed control efficiency of 83.27, 77.02 and 64.13% at 25, 50 and 75 DAT, respectively. Although two rounds of hand weeding or mechanical weeding could keep the weeds under control from the beginning till harvest, these were cost-prohibitive. Superiority of manual weeding regarding effective weed management and higher productivity was also reported by Adhikary *et al.* (2016) and Shil and Adhikary (2014).

Effect on crop growth

The plant height was significantly influenced by different weed management practices at 75 and 100 DAT (**Table 2**). The highest plant height (46.07 cm) was found under two hand weeding treatment at 100 DAT, which remained at par with the application of propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha *fb* MW at 40 DAT. Weedy check plots registered the lowest plant height of 30.75 and 37.13 cm at 75 and 100 DAT, respectively. Two hand weeding and propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha + MW) recorded the higher chlorophyll content (49.61 and 47.81, respectively) at 75 DAT. Hand weeding is a method that removes competing weeds from onion plants, allowing them to access more sunlight, water, and nutrients, promoting growth. This leads to increased plant height and efficient photosynthesis. Additionally, hand weeding ensures better soil nutrient uptake, supporting overall plant growth. Weeds can induce stress on onion plants by competing for resources and releasing allelopathic chemicals, but hand weeding reduces this stress, allowing plants to focus on growth and chlorophyll production. Both the treatments maintained similar trend in influencing chlorophyll content at 100 DAT. At 100 DAT, the leaf area index (LAI) was maximum in two hand weeding (4.66), followed by the treatment of propaquizafop + oxyfluorfen + MW (3.85). The maximum dry matter accumulation (DMA) at 25 DAT (**Table 2**) was recorded in the treatment received two hand weeding (16.08 g/m^2), which remained at par with the IWM treatment (propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha + MW). These treatments also recorded higher DMA at 75 and 100 DAT, whereas it was always the lowest in weedy check plots (12.78, 27.29, 83.24 and 190.00 g/m^2 at 25, 50, 75 and 100 DAT, respectively). There was a significant effect of weed control treatments on crop growth rate (CGR) over a period of time (**Table 2**). The CGR ranged

Table 2. Effect of treatments on plant height, chlorophyll content, leaf area index, dry matter accumulation and crop growth rate of onion (pooled over two years)

Treatment	Plant height (cm)		Chlorophyll content (SPAD value)		Leaf area index (LAI)		Dry matter accumulation (DMA) (g/ m^2)				Crop growth rate (CGR) (g/m^2/day)		
	75 DAT	100 DAT	75 DAT	100 DAT	75 DAT	100 DAT	25 DAT	50 DAT	75 DAT	100 DAT	25-50 DAT	50-75 DAT	75-100 DAT
Weedy check	30.75	37.13	37.31	35.25	2.09	3.21	12.78	27.29	83.06	190.0	0.58	2.23	4.28
Two HW	36.00	46.07	49.16	46.33	3.36	4.66	16.08	39.42	101.61	290.9	0.93	2.49	7.57
Two MW	33.13	42.84	43.15	41.14	2.80	3.45	14.57	32.17	93.94	279.8	0.70	2.47	7.43
Propaquizafop + oxyfluorfen *Fb* MW	34.58	45.55	47.81	44.94	3.21	3.85	15.14	38.24	100.19	284.7	0.92	2.48	7.38
Cucumber aqueous extract 10% *fb* MW	33.75	43.53	45.14	42.69	2.95	3.53	14.69	36.58	96.53	272.8	0.88	2.40	7.05
LSD (p=0.05)	2.15	1.37	2.76	2.89	0.33	0.76	1.50	2.08	3.96	28.6	0.04	NS	1.17

from 0.58 to 0.93 g/m^2/day during 25-50 DAT. The pooled data revealed that the maximum CGR in two HW (0.93 g/m^2/day), which was at par with the IWM (propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha + MW) treatment (0.92 g/m^2/day). Higher dry matter accumulation per plant was observed in these treatments due to effective control of weeds after imposing the treatments at the early stages of crop growth. As a result, the crop had put forth luxuriant growth and produced more number of leaves and reproductive parts which in turn produced more dry matter accumulation per plant. But it was the minimum in weedy check treatment. Gaharwar *et al*. (2017) reported similar findings.

Effect on yield

Weeds seriously affected bulb development and drastically reduced yield. Two hand weeding (20 and 40 DAT) recorded the highest bulb diameter (51.62 mm), length of bulb (60.49 mm) and number of scales/bulb (7.53) which was at par with propaquizafop + oxyfluorfen followed by PE application of cucumber aqueous extract 10% *fb* MW at 40 DAT (**Table 3**). While, the minimum bulb diameter (37.38 mm), bulb length (46.75 mm), number of scales per bulb (6.03) was recorded in the weedy check treatment. Variability in bulb development was due to different weed control methods which influenced the nutrient availability to the crop plants through various mechanisms. The interaction between weed management practices and nutrient dynamics in the soil is complex and can impact nutrient availability both directly and indirectly. Weeds compete with crop plants for essential nutrients, water, and sunlight. When weeds are present, absorb and utilize nutrients that would otherwise be available to the crop. This can lead to nutrient deficiencies in crop plants, affecting their growth and yield. Some weeds release allele-chemicals into the soil, which can have allelopathic effects on nearby crops. These chemicals may inhibit the germination, growth, or nutrient uptake of crop plants, reducing their ability to access and utilize nutrients from the soil. Two hand weeding (20 and 40 DAT) registered significantly the highest bulb yield (18.17 t/ha), which was at par with propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha PE *fb* MW treatment (17.26 t/ha). On the other hand, application of cucumber aqueous extract 10% (PE) *fb* MW at 40 DAT was found to be statistically at par with two mechanical weeding (20 and 40 DAT) treated plot. The biological yield (25.90 t/ha) was recorded in the treatment HW at 20 and 40 DAT, and it was at par with the propaquizafop + oxyfluorfen (25.12 t/ha). Whereas, significantly the lowest bulb yield (5.50 t/ha) and biological yield (10.78 t/ha) was recorded in the weedy check treatment. The main reason was due to the presence of more number of broad leaved, grassy and sedges weeds associated with the crop which exhibited severe competition throughout the crop growth. And no significant effect was observed in harvest index of onion. These results in respect of yield attributes were in close conformity with the earlier findings of Kalhapure and Shete (2012) and Thakare *et al*. (2018).

Economics

Maximum net monetary return was obtained from the treatment receiving propaquizafop + oxyfluorfen (tank mix) PE at 1DAT *fb* MW at 40 DAT (₹ 98630/ha), followed by two hand weeding (₹ 94235/ha). But in terms of benefit cost ratio, the application of cucumber aqueous extracts 10% (PE) *fb* MW at 40 DAT registered better result (B:C ratio 3.20) than two hand weeding and positioned after chemical herbicide *fb* MW treated plots (B:C ratio 3.50). Whereas the weedy check treatment registered the lowest net return (₹ 9875/ha) and B:C ratio (1.29). Though hand weeding treated plots registered the highest yield, it was cost-prohibitive and ineffective due to high labor cost, timely unavailability of skilled labor and high time requirement. With the timely

Table 3. Effect of treatments on various yield attributes, yield and economics of onion (pooled over two years)

Treatment	Bulb diameter (mm)	Bulb length (mm)	Scales/ bulb	Bulb yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Cost of cultivation (`/ha)	Gross return (`/ha)	Net return (`/ha)	B:C ratio
Weedy check	37.38	46.75	6.03	5.50	10.78	51.02	34125	44000	9875	1.29
Two HW	51.62	60.49	7.53	18.17	25.90	70.15	51125	145360	94235	2.84
Two MW	48.65	56.31	6.22	12.52	20.14	62.16	40625	100160	59535	2.47
Propaquizafop + oxyfluorfen *fb* MW	50.41	59.19	7.24	17.26	25.12	68.71	39450	138080	98630	3.50
Cucumber aqueous extract 10% *fb* MW	49.00	57.48	6.46	14.23	21.96	64.80	35625	113840	78215	3.20
LSD (p=0.05)	1.05	1.38	0.76	1.77	2.09	NS	-	-	-	-

unavailability of safer chemicals in rural areas, the aqueous extracts of cucumber leaf in combination with mechanical weeding (MW) might be an alternative and feasible option. Adhikary *et al.* (2014 and 2016) reported similar findings.

The study concluded that the integrated weed management practices involving either application of propaquizafop 0.05 kg/ha + oxyfluorfen 0.25 kg/ha (tank mix) at 1 DAT *fb* mechanical weeding at 40 DAT, or aqueous extract of cucumber (*Cucumis sativus* L.) plant 10% 2.5 liters/ha at 1 DAT *fb* mechanical weeding at 40 DAT might be the possible options for cost-effective weed management in onion under irrigated condition in West Bengal.

REFERENCES

Adhikary P, Patra PS and Ghosh RK. 2014. Efficacy of plant extracts as bioherbicide on weeds in soybean ecosystem. *Green Farming* **5**(3): 486–488.

Adhikary P, Patra PS and Ghosh RK. 2016. Influence of weed management on growth and yield of groundnut (*Arachish ypogaea*) in gangetic plains of West Bengal, India. *Legume Research* **39** (2): 274–278.

Adhikary P. 2012. *Weed seed bank analysis in blackgram – brinjal – mustard cropping sequence*. M. Sc. (Ag) Agronomy, Thesis submitted to Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia, West Bengal, India.

Adhikary P. 2018. Weed management in blackgram. *Indian Journal of Weed Science* **50**(4): 369–372.

Anonymous. 2021. Ministry of Agriculture Government of India, www.agricrop.nic.in.

Gaharwar AM, Patil N and Ughade JD. 2017. Effect of integrated weed management on growth, yield and economic returns on onion (*Allium cepa* L.). *Asian Journal of Horticulture* **12**(2): 193–197.

Gomez KA and Gomez AA. 1984. Statistical Procedures for Agriculture Research. JhonWileyand Sons. New York.

Kalhapure AH and. Shete BT. 2012. Integrated weed management in onion. *Indian Journal of Weed Science* **44**(2): 88–91.

Kumari S, Kumar R, Das SN and Kavita. 2019. Performance of different herbicides on weed control in onion (*allium cepa* l.) and its effect on economics. *Current Journal of Applied Science and Technology* **33**(2): 1–5.

Noguchi,HK,Thia, HLe, Teruyac T andSuenagac, K. 2015. Twopotent allelopathic substances in cucumber plants. *Scientia Horticulturae* **129**: 894–897.

Shil S and Adhikary P. 2014. Weed management in transplanted chilli. *Indian Journal of Weed Science* **46**(3): 261–263.

Thakare SS, Chirde PN, Shingrup PV, Deshmukh JP, Kakde SU and Gholap AN. 2018. Weed Management in Onion by Pre- and Post-emergence Herbicides. *International Journal of Current Microbiology and Applied Sciences* **6**: 2197–2202.