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Short communication

Flurochloridone -A promising herbicide for weed management in carrot

Ramesh Kumar Singh, Neelam Bisen* and Meena Rani
Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005

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Carrot (*Daucus carota* L.) is an important vegetable crop grown in spring, summer and autumn for fresh market and processing under tropical, sub-tropical and temperate climate. It is a high value cash crop and rich source of vitamin-A, which helps people to improve the nutritional quality of their diets. Weed control in carrots is very important due to early slow crop growth and lack of competitiveness with weeds. Without weed control, yields are often reduced by more than 90% (Swanton *et al.* 2009). Manual weeding is widely practiced for controlling weeds which is costly and have certain limitations, *viz.* hike in high labor wages, timely unavailability of labour and soil physical conditions that often limit physical and mechanical weeding. Hence, there is a need to find out alternate methods of weed control. Herbicide based weed management is becoming popular among farmers on account of its lower cost and effective weed control. As limited herbicides are available for weed control in carrot, herbicide flurochloridone was evaluated against infestation of complex weed flora in carrot.

Present study, was conducted at Agriculture Research Farm Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh during *Rabi* seasons of year 2014-15 and 2015-16. The soil at the location was sandy loam in texture with normal (pH 7.4) reaction. The treatments comprised of flurochloridone at 500, 625 and 750 g/ha as pre-emergence and was compared with pendimethalin 1000 g/ha and metribuzin 525 g/ha. The efficacy of these treatments was assessed against two hand weeding and untreated treatments in a randomized block design replicated thrice. A water volume of 500 L/ha was used for the application of the herbicide using flat fan nozzle fitted in a plot sprayer. The carrot crop was grown with recommended package of practices in the region. Three places in each treatment were selected at random and marked with pegs. Species wise weed count was recorded by placing 1 m^2 quadrate in marked area at 45 days after herbicide application (DAA). Hand weeding was taken up at 25 and 50 days after sowing. For quantifying weed biomass, the weed samples were sun dried for four days and then in hot air oven for drying at 60 ^{0}C and dry weight (g/m^2) was recorded separately for each species. The crop was harvested at maturity and fresh carrot yield was recorded in kg/plot and converted to t/ha. The data on density and biomass of different weeds were pooled and subjected to square root transformation before statistical analysis and significant difference were compared by critical difference at 5% level of probability.

***Corresponding author:** neelam.bisen25@gmail.com

Weed flora

The dominant weed flora observed in experimental field comprised of both narrow-leaf weeds, *viz. Cyperus rotundus* and *Cynodon dactylon*, broad-leaf weeds *viz. Chenopodium album, Melilotus* spp. and *Trianthema portulacastrum*. Sporadic presence was observed of *Anagallis arvensis, Physalis minima* and *Parthenium hysterophorus*.

Effect on weed biomass and weed control efficiency

The pooled data of two years indicated that weed density and dry biomass of major weeds were significantly lower in herbicide treated crop as compare to untreated (**Table 1**). Pre-emergence application flurochloridone 750 g/ha was statistically at par with flurochloridone 625 g/ha in causing significant reduction in biomass of all weeds when compared to pendimethalin at 1000 g/ha and metribuzin at 525 g/ha. Pre-emergence application of herbicides gave effective control of weeds by inhibiting the germination of weeds and also killing the emerging weeds at early stages (Vyas *et al.* 2000). Application of herbicides at pre-germinating stage in crop was found to control poaceae weeds and broad-leaved weed effectively (Khare and Jain 1995). Dobrzanski and Palczynski (1998) also found same result in case of different root vegetables.

Table 1. Effect of weed management treatments on weed density and biomass of major weeds associated with carrot at 45 DAA (pooled data)

Treatment	Dose (g/ha)	Weed density (no./m^2)					Dry weed biomass (g/m^2)				
		C. dectylon	*C. rotundus*	*T. portulacastrum*	*C. album*	*Melilotus sp.*	*C. dectylon*	*Cyprus rotundus*	*T. portulacastrum*	*C. album*	*Melilotus* sp.
Flurochloridone	500	3.28(1.94)	3.00(1.87)	3.78(2.07)	5.44(2.44)	4.17(2.16)	2.90(1.84)	2.71(1.79)	4.46(2.23)	7.18(2.77)	4.68(2.28)
Flurochloridone	625	1.06(1.25)	1.00(1.22)	1.22(1.31)	1.73(1.49)	1.45(1.39)	1.38(1.37)	1.39(1.37)	1.99(1.58)	3.34(1.96)	2.08(1.61)
Flurochloridone	750	0.95(1.20)	0.89(1.18)	1.06(1.25)	1.56(1.43)	1.28(1.33)	1.22(1.31)	1.22(1.31)	1.80(1.51)	3.10(1.90)	1.88(1.54)
Pendimethalin	1000	1.67(1.47)	4.06(2.13)	1.78(1.51)	2.06(1.60)	2.17(1.63)	1.98(1.57)	3.90(2.10)	2.70(1.79)	4.26(2.18)	2.74(1.80)
Metribuzin	525	1.50(1.41)	1.45(1.39)	1.73(1.49)	2.22(1.65)	2.06(1.60)	1.80(1.51)	1.88(1.54)	2.55(1.74)	4.07(2.14)	2.53(1.74)
Hand weeding	25&50 DAS	0.78(1.13)	0.78(1.13)	0.89(1.18)	1.39(1.37)	1.11(1.27)	1.07(1.25)	1.10(1.26)	1.62(1.46)	2.89(1.84)	1.71(1.49)
Untreated	-	13.1(3.68)	12.1(3.55)	14.8(3.92)	21.9(4.74)	16.9(4.18)	11.3(3.44)	10.7(3.34)	17.7(4.26)	28.5(5.39)	18.3(4.33)
LSD (p=0.05)		0.14	0.14	0.17	0.13	0.15	0.12	0.15	0.16	0.17	0.12

Figures in the parentheses are square root transferred ($\sqrt{x+0.5}$) values, DAS= Days after sowing, DAA= Days after application

Table 2. Effect of weed management treatments on weed control efficiency at 45 DAA and carrot yield (pooled data)

Treatment	Dose (g/ha)	Weed control efficiency					Carrot yield (t/ha)
		Cynodon dactylon	*Cyperus rotundus*	*Trianthema portulacastrum*	*Chenopodium album*	*Melilotus sp.*	
Flurochloridone	500	74.25	74.55	74.39	74.845	74.76	25.01
Flurochloridone	625	87.56	87.08	88.65	88.26	88.88	29.88
Flurochloridone	750	89.01	88.67	89.81	89.105	89.97	30.34
Pendimethalin	1000	81.92	67.11	84.68	85.04	85.19	27.50
Metribuzin	525	83.60	82.57	85.86	85.695	86.07	27.90
Hand weeding	25&50 DAS	90.40	89.78	90.86	89.86	90.81	31.14
Untreated	-	-		-	-	-	22.92
LSD (p=0.05)	-	-	-	-	-	-	1.50

DAA= Days after application, DAS= Days after sowing

Criterion for herbicide weed control efficiency (WCE) was taken as the % of reduction in weed biomass in particular treatment in comparison to untreated control. Amongst herbicides, maximum weed control efficiency was recorded in flurochloridone 750 g/ha, which was closely followed by flurochloridone 625 g/ha and both had higher WCE than pendimethalin and metribuzin against both narrow- and broad-leaf weeds.

Carrot yield

The highest carrot yield was recorded with two hand weeding (31.14 t/ha). It was at par to flurochloridone 750 g/ha (30.34 t/ha) and flurochloridone at 625 g/ha (29.90 t/ha). Both these treatments had significantly higher yield than pendimethalin 100 g/ha (27.53 t/ha) and metribuzin 70% WP (27.90 t/ha) (**Table 2**). All the herbicides treatment showed significantly higher carrot yield over the untreated treatment. This might be due to less crop-weed competition for moisture, light and nutrient and efficient utilization of resources by carrot in herbicide treated and hand weeded treatments resulting in higher assimilation of photosynthesis and higher carrot yields.

Thus, it was concluded that for effective control of weeds and higher yield of carrot, flurochloridone 625 g/ha as pre-emergence can be recommended under agro-climatic conditions of Varanasi.

SUMMARY

Field experiment was conducted during *Rabi* season of 2014-15 and 2015-16 at agricultural research farm of Banaras Hindu University, Varanasi (Uttar Pradesh) to study the bio-efficiency of flurochloridone on narrow and broad-leaved weeds in carrot. Flurochloridone 500, 625 and 750 g/ha, pendimethalin 1000 g/ha and metribuzin 525 g/ha were applied as pre-emergence. Maximum reduction in different weed species biomass was observed with flurochloridone 750 g/ha followed by flurochloridone 625 g/ha. Weed control efficiency was highest with flurochloridone at 750 g/ha for all the weed species. Carrot yield was maximum with two hand weeded treatment (31.14 t/ha) and was comparable to flurochloridone 750 g/ha and flurochloridone 625 kg/ha.

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