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IMPACTS OF SOIL SOLARIZATION COMBINED WITH OTHER WEED CONTROL STRATEGIES ON WEED MANAGEMENT IN ONION NURSERIES

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Abstract

A field experiment was conducted at The University of Agriculture Peshawar- Pakistan, during September - October 2010, to determine the effects of soil solarization in combination with different weed control strategies on weed management in onion nurseries. The experiment was laid out in Randomized Complete Block Design and each treatment being replicated three times. Factor A (solarization vs. non-solarization) assigned to main plots while factor B (various other weed control strategies) allotted to sub-plots. The solarized plot was covered with a transparent plastic sheet for 20 days. After removal of the sheets, the plot was ploughed. Seed of onion cultivar (Swat-1) were broadcasted on flat beds at the rate of 20 g m^{-2} after a seed germination test. After sowing the seed, a light watering was performed through a garden jerry can and later on the beds were watered as per requirement. The main plot was divided into 16 sub-plots (each 1 m^2). After removal of plastic sheet sedges and grassy weeds were found in abundance as compared to broad leaf weeds. Plastic sheets encouraged weed germination, because during the particular time of the year (25th Sept. -15th Oct.) the heat produced and the moistures conserved by plastic mulches favoured weed seeds germination. And as a result weeds infestation was more in the solarized plot than the non solarized plot. Stomp 330 EC and Parthenium hysterophorus L. mulch controlled weeds but also affected onion seedlings growth adversely. Grass clippings as mulch boosted the growth of the broad leaf weeds particularly of the curly dock. Isoprotoron effectively controlled Cyperus rotundus L., Coronopus didymus L., Fumaria indica L., and Cirsium arvense L. but did not control Cynodon dactylon L. and Convolvulus arvensis L.

Key words: Hand hoeing, onion nurseries, solarization, weed control.

INTRODUCTION

Onion (*Allium cepa* L.; Alliaceae) is a vegetable crop and is used as condiment in daily diet and helps to fight against blood and heart diseases. It is a cool season plant, hardy to frost but less sensitive to high temperatures. The optimum temperature for its seedling growth is 20 - 25ºC. Its growth decline at temperatures

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higher than 27ºC. The requirement of day length of different cultivars may differ. Long day varieties do not bulb under short day whereas short day varieties, if planted under long day, develop bulbs (MINFA, 2001). In our province onion was grown on an area of 105.6 thousand hectares with annual production of 1488.5 thousand tons during 2009-10 in Pakistan, while in our province it was grown on an area of 12.1 thousand hectares with an annual production of 136.37 thousand tons (MINFA, 2010).

Soil for onion should be deep friable and highly fertile. Onions can, however, be grown in all types of soils. For high yield and quality bulbs, cool soils are ideal. In general, sandy loam to clay loam soil is recommended (Malik, 1994). The optimum pH range is from 5.8 to 6.5. Alkaline and saline soils are not suitable for onion production. Good drainage is essential as water logging can cause total failure of the crop. Onion cannot be seeded directly and its seeds are sown in nursery beds to raise seedling. For nursery raising, raised beds of about 3 m long, 0.6 meter wide and 20-30 cm high are prepared. About 0.7 m distance is kept between 2 beds to carry out operations of watering, weeding etc. The surface of beds should be smooth and leveled. Raised beds are necessary to avoid problem of water logging in heavy soils. In sandy soils, however, nursery can be raised on beds. Traditionally sowing is done by broadcasting the seeds but scientifically seed should be treated with Thiram @ 2 g/kg of seed to avoid damage from damping off disease. The soil of nursery should also be treated with Thiram or Captan @ 4-5 g/m² area.

Soil solarization has been an effective method of weed control for most weed species (Elmore, 1995). During the seasons 2005-2006, significant reduction in the number of weeds was obtained in onion seed beds through soil solarization. They utilized ultraviolet transparent polyethylene and compared with control without Solarization and obtained an excellent control of weeds. The solarization was also effective in reducing the damages caused by nemathodes in plantlets of onion in 2008 (Arbopleya, 2009). In case of soil solarization the nursery beds should be irrigated 15-20 days before sowing and covered with 250 gauge transparent polythene. The seeds after sowing should be covered with fine powdered farmyard manure or compost followed by light watering through garden can. The beds should then be covered with dry straw or grass or sugarcane leaves to maintain optimum temperature and moisture. Watering should be done by a garden can as per the need till germination is completed. Dry straw or grass is removed immediately after germination is completed. Delay in removal of dry straw and grass may result in lanky seedlings (Rayes, 1994).

Weeds are present as seeds or propagules in the soil at the

time of crop planting. As the crop establishes, weeds also grow unless they are controlled. The greatest weed competition occurs in the first 4 weeks of establishment. As mechanical seeding and cultivation increases, weeds must be controlled in the seed-line (Elmore, 1995). Weeds infestation is one of the major constraints in onion nursery production in our country. Very little and negligible work has been done in this regard in our country as well as worldwide. To combat weeds in onion nursery most of work is focused on chemical weed management and very little work has been done on non chemical or organic weed control. Now days the trend has been changed to non chemical and environmental friendly techniques like soil solarization, mulch and other cultural methods. Keeping in view the importance of cultural and non chemical weed control in onion nursery production. This experiment is therefore conducted with the objectives to study the effect of soil solarization as weed control tool in onion nurseries, to investigate the effect of organic mulches in combination with soil solarization on weed control and nursery development, and to compare the efficacy of non-chemical weed control with different herbicides for weed control in onion nurseries.

MATERIALS AND METHODS

A field experiment was conducted at the University of Agriculture Peshawar-Pakistan to determine the effect of soil solarization in combination with different weed control strategies like mulches and herbicides on weed management in onion nurseries. The experiment was laid out in Randomized Complete Block Design having 3 replications. Factor A (solarization vs. non solarization) was assigned to main plots while factor B (various weed control strategies) was assigned to sub-plots. Transparent plastic sheets were used for solarization. The plot was covered for 20 days (i.e., 25 September to 15 October). Plastic sheets were removed and weed data was taken and then ploughed both plots. Onion seed of variety "Swat-1" were broadcasted at the rate of 20 gram m^{-2} on flat beds after seed germination test. Light irrigation was done subsequently, and later on the beds were irrigated as per requirement. Each plot was divided into 16 beds each of $1m^2$. After sowing the following 6 treatments were applied.

Treatments

T1 Stomp @ 3 mL m^{-2} as pre emergence herbicide
T2 *Parthenium hysterophorus* L. as mulch (whole plant chopped finally)
T3 Bermuda grass clippings
T4 Iso-proturon 50% SC @ 7 g m^{-2} as post emergence herbicide
T5 Hand weeding
T6 Weedy check

Stomp 3309 EC @3 mL m^{-2} as pre emergence was applied two weeks after sowing. *Parthenium hysterophorus* L. and Bermuda grass clippings mulches were applied 3 week after sowing. Isoproturon 50% SC @7 g m^{-2} as post emergence was applied 30 days after sowing. Hand weeding was done at the interval of one week.

Data was recorded on numbers of weeds m^{-2} before sowing and after soil solarization, numbers of weeds m^{-2} after 6 weeks of sowing, numbers of onion seedlings m^{-2}, and seedling vigor.

RESULTS AND DISCUSSION

It is clear from the data (Table-1) that soil solarization effected weed seed germination, by decreasing broadleaf and grassy weeds germination while increased sedges (Hossein *et al*., 2005). After removal of polythene sheet sedges were found to be extensive and covered the whole plot. In contrary the non-solarized plots contain few of sedges while grassy leaf weeds were found in abundance. The application of polythene sheets boosted sedges sprouting from tubers and not from seeds. Solarization increased soil temperature by 11.5^{o}C over non-solarized soil at 10 cm depth, reduced soil-borne pests, conserved moisture, increased the availability of essential nutrients in the soil and hence enhanced the growth (Ahmad and Ghaffar, 2007). Because of the particular duration and time of the year the heat and humidity produced under polythene sheets made the environmental conducive for the *Cyprus* species to sprout and disfavoured emergence from seeds (Candido *et al*., 2006). Solarization is an environment-friendly technology but it could be used successfully in some particular agricultural regions, crops and environments (De Vay, 1995).That is why only the perennial weeds were in abundance under the polythene sheets. For this major reason sedges were extensive in the soil solarized plot than the non solarized plot. The solarized plot was also infested with *Cronopus didymus* L. besides sedges (*Cyperus rotundus* L.). So, it could be stated that soil solarization for this particular period of time and temperature enhances weed infestation. Broad leaf weeds like *Cronopus diyimus* L., *Rumix crispus* L., *Cirsium arvense* L., *Fumaria indica* L. and *Euphorbia heloscopia* L were found to be more extensive than sedges and grassy weeds in the non-solarized plot. The moisture content in the non-solarized plots were also less comparatively. Besides broad leaf weeds *Cynodon dactylon* L., and sedges were common throughout the field. Recently, Khan *et al*. (2012) reported that soil solarization decreased the weed density.

Stomp 330EC provided a considerable weeds control in the solarized as well as non-solarized plots as compared to weedy check (Marwat *et al.*, 2005). *Parthenium hysterophorus* L. was also used as organic mulch in the experiment. The results were good but the onion

seedlings were also affected adversely. The plants were applied in vegetative stage to the field. In case of *Parthenium hysterophorus* mulch the weeds were not boosted but the onion seedlings were affected adversely. Clipping were used as organic mulch in the experiment. The results were satisfactory and were not effective as much as all the other weed control strategies. During its duration boosted the growth of the broad leaf weeds and curly dock was found to be extensive in grass clipping mulches.

Table-1. Weeds (m^{-2}) recorded after solarization and before sowing as affected by soil solarization and various weed control strategies.

Treatments	Solarized plot			Non solarized plot		
	Broad leaved weeds	Grassy weeds	Sedges	Broad leaved weeds	Grassy weeds	Sedges
Stomp 330 EC	21	13	196	133	158	17
Parthanium	24	09	188	100	11	23
Grass clipping	19	05	185	211	122	82
Isoprotoron	15	12	251	33	12	19
Hand Weeding	17	08	213	21	11	39
weedy check	26	15	227	177	121	23
Means	20.3	10.3	210.0	112.5	72.5	33.8

Table-2. Weeds (m^{-2}) recorded six weeks after sowing as affected by soil solarization and various weed control strategies.

Treatments	Solarized plot			Non solarized plot		
	Broad leaved weeds	Grassy weeds	Sedges	Broad leaved weeds	Grassy weeds	Sedges
Stomp 330 EC	31	17	28	29	22	37
Parthanium	75	23	47	100	11	23
Grass clipping	79	15	23	100	20	00
Isoprotoron	21	16	35	33	12	19
Hand Weeding	14	20	26	21	11	39
weedy check	53	37	94	91	25	47
Means	45.5	21.3	42.2	62.3	16.8	27.5

Isoprotoron was used as post emergence herbicide. Recommended rate of Isoproturon for onion nursery is 1 kg/ha (Ghosheh, 2004) and was applied at the rate of 7gm/square meter

area. Isoproturon was applied to the target beds after 3 weeks of emergence of onion seeds and showed good results and both type of weeds were controlled effectively. It controlled (*Cyperus rotundus* L.), (*Cronopus didymus* L.), (*Fumaria indica* L.), (*Circium arvense* L.), effectively but was not effective against weeds like (*Cynodon dactylon* L.) and (*Convolvulus arvensis* L.).

Hand hoeing was started when the weeds 3 weeks old and was done after every 5 days. Because of the small area hand hoeing was effective and weeds were not able to compete and the beds were not infested by the weeds throughout the experiment. Hand hoeing was found to be the most effective weed control measure as compared to other weed control strategies. Because of crop and weed mimicry at the early seedling stage it is difficult to differentiate between the weed and crop. At the early stage it is difficult to differentiate between the (*Allium cepa* L.) seedlings and (*Cyperus rotundus* L.) because of its mimicry.

Weedy check

This treatment was left as such and no control strategy was applied throughout the experiment. The weeds emerged within first 2 weeks before the germination of onion seeds. Besides this the density of weeds was greater than onion seedlings (Hussain *et al.*, 2008). As onion is a poor competitor due to low plant density and slow initial growth and can be affected by very low weed density. (Tei and Pannacci, 2005). Because of high competition the weeds were taller and spread throughout the beds which were assigned as weedy check and no control strategies were applied .

Table-3. Onion seedlings (m^{-2}), seedling vigor and seedling length six weeks after sowing as affected by soil solarization and various weed control strategies.

Treatments	Solarized plot			Non solarized plot		
	Onion seedlings m^{-2}	seedling vigor	Seedling length (cm)	Onion seedlings m^{-2}	seedling vigor	Seedling length (cm)
Stomp 330 EC	87	Normal	7	107	Normal	9
Parthanium	68	Normal	7	42	Weak	6
Grass clipping	61	Weak	5	40	Weak	5
Isoprotoron	68	Weak	6	77	Normal	8
Hand Weeding	97	Good	12	113	Good	12
weedy check	71	Normal	9	57	Weak	7
Means	75.3	-	7.7	72.7	-	7.8

The onion seedlings were found to be very vulnerable and were affected by the high density and competition of weeds. Both kinds of

weeds were found, grassy as well as broad leaf weeds. In non solarized plot as compared to the non solarized plot the competition was not so severe, but in the non solarized plot the diversity of weed as well as the competition was severe as compared to the solarized plot. Although the 2 types of weeds (*Cyperous rotundus* L.) and (*Cronopus didymus* L.) both were severe and were spread throughout the field. Other kind of weeds that were found are *Rumix crispus* L.*, Avena fatua* L.*, Sorghum halepense* L.*, Cynodon dactylon* L.*, Convolvulus arvensis* L., *Cirsium arvense* L.*, Euphorbia helioscopia* L.*, Cyperus rotundus* L.*,* and *Fumaria indica* L*.*

CONCLUSION

Further research should be conducted to know about the Plastic sheets encouraged weed germination, Grass clippings as mulch boosted the growth of the broad leaf weeds particularly of the curly dock. Hand hoeing was the most effective weed control measure as compared to other weed control strategies but being more laborious and less economical.

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