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Research Paper

Effect of land configuration and weed management in onion (*Allium cepa*)

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ABSTRACT

A field experiment was conducted to examine the effect of different planting patterns and weed management practices on weed growth and productivity of onion (*Allium cepa* L.) during *rabi* 2006-07 and 2007-08. The experiment was laid out in split-plot design with planting patterns of onion in main-plots (flat and raised bed planting with or without rice straw incorporation) and weed management practices viz., pendimethalin @ 0.75 kg/ha, oxyflourfen @ 0.225 kg/ha, fluchloralin @ 1.125 kg/ha, two hand weedings and control (unweeded) in sub-plots. Weed population and dry matter accumulation of weeds under different planting patterns and straw management techniques remained unaffected throughout the crop growth period and at uprooting. Yield attributes and bulb yield were not significantly influenced by planting patterns. Population and dry matter accumulation of weeds were significantly reduced with the application of oxyflourfen, pendimethalin and two hand weedings, when compared with fluchloralin and unweeded control during both years of investigation. Application of oxyflourfen gave the highest bulb yield, which was at par with pendimethalin and two hand weedings. These treatments gave significantly more bulb yield than fluchloralin and unweeded control. The highest net returns obtained with flat bed sowing with rice straw incorporation. Among the different weed control treatments, the maximum net returns of ₹185.6×10^3/ha with BCR 7.63 registered with oxyflourfen. Unweeded control treatment recorded the lowest net returns of ₹94.3×10^3/ha with BCR 4.10.

Key words **:** Land configuration**,** Onion, Productivity, Weed management

Onion is one of the most important vegetable crops in India. India is the second largest producer of onion in the world, next to China. In India, it occupies an area of 0.75 million hectares with a production of 12.2 million tonnes while in Punjab, it covered an area of 8.1 thousand hectares with a production of 174.1 thousand tonnes during 2009-10 (Anonymous 2010).

Severe weed problems in onion and huge losses due to weed competition are a global problem. Weeds interfere with the development of onion bulb by competing for moisture, nutrient, light and space and thereby reduce bulb yield to the extent of 40-80% (Verma and Singh, 1996 ; Tewari *et al.*, 2003). Owing to inherent characteristics of onion such as, short stature, non branching habit, sparse foliage, shallow root system and extremely slow growth in initial stages, weeds offer severe competition throughout the crop growth. The conventional method of weed control i.e. hand weeding is labour intensive, time consuming, cumbersome and under many situations uneconomical. Pendimethalin, oxyflourfen and fluchloralin are few selective herbicides recommended for controlling weeds in onion. Land configuration is also an important aspect to study. Planting of onion on raised beds significantly increased plant height, number of leaves per plant, plant stand, bulb yield and reduced bulbing ratio (neck diameter : bulb diameter) and small bulb yield as compared to flat planting (Farrag, 1995). There is need to develop most effective and economical weed control and planting pattern for obtaining higher yields of onion as well as profitability in its production. Keeping this in view, the present study was made to assess the impact of planting pattern and weed control treatments on weed growth and onion performance.

MATERIALS AND METHODS

The field experiment was conducted at the Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana situated between 30°56' N latitude, 75°52' E longitude and at an altitude of about 247 m above msl to study the effect of planting and weed control methods on weeds and productivity of onion during the crop years 2006-07 and 2007-08. The experimental site was a loamy sand in texture, low in organic carbon (0.29%) and available nitrogen (180 kg/ha), high in available phospho-

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rus (29.6 kg/ha) and medium in available potassium (153 kg/ha) in 0-15 cm soil depth. The soil was slightly alkaline in reaction (pH- 7.5) with an electric conductivity of 0.2 ds/m. The experiment was laid out in split-plot design with four replications. The experiment consisted of four planting patterns *viz.,* flat bed (FB), flat bed with rice straw incorporation (FBRI), raised bed (RB) and raised bed with rice straw incorporation (RBRI) in main-plots and five weed control treatments viz., pendimethalin @ 0.75 kg/ha, oxyflourfen @ 0.225 kg/ha, fluchloralin @ 1.125 kg/ha, two hand weedings at 3 and 6 weeks after sowing and control (unweeded) in sub-plots. The gross sub-plot and net-plot size of flat bed and raised bed was 30 m^2 and 24 m^2, respectively.

The nursery of onion 'Punjab Naroya' was sown in last week of October in both the years of study. Nursery land received decomposed farmyard manure (125 kg/200 m^2), was irrigated 10 days before sowing of nursery to allow complete germination of weeds. The land was ploughed and leveled. Seeds (10 kg/ha) were sown on raised beds of 15 cm height in rows 5 cm apart. Nursery beds were irrigated immediately after sowing and later as and when required.

After harvesting the rice, main field was ploughed twice with disc harrow and once with a cultivator followed by planking in case of conventional tillage and after applying rice residue in case of residue incorporation treatments. Regarding raised beds, 37.5 cm wide beds and 30 cm wide furrows were prepared with bed planter. The seedlings were transplanted in the first week of January in both the years of study in four rows on the raised beds at a spacing of 12 cm × 7 cm and at spacing 15 cm × 7.5 cm in flat beds keeping the equal number of plants per unit area. Recommended doses of N (100 kg/ha), P_2O_5 (50 kg/ha) and K_2O (50 kg/ha) were applied through urea, single superphosphate (SSP) and muriate of potash (MOP), respectively. Half the dose of urea and entire dose of SSP and MOP were applied at the time of transplanting and the remaining half dose of N was broadcast after first irrigation. Eleven irrigations were given at 10 days interval and the last irrigation was given approximately 15 days before the harvest. Fluchloralin @ 1.25 kg/ha was sprayed preplant while oxyflourfen @ 0.225 kg/ha and pendimethalin @ 0.75 kg/ha were applied one week after sowing (after first irrigation).

The uprooting of the bulbs was done manually in the first week of May in both the years of study. After harvest, the bulbs were cured under shade and then leaves were cut 1-2 cm above the bulb and the bulb yield (t/ha) was recorded. Data were also recorded on weed density/m^2, weed dry matter (g/m^2), fresh weight of onion bulb (g) and bulb diameter (cm). The weed control efficiency (WCE) was calculated by using the following formula (Singh *et al*., 2000).

WCE = (DMC-DMT)/DMC × 100

Where, DMC is dry matter of weeds in control (unweeded) and DMT is dry matter of weeds in a particular treatment.

To work out economics, B:C ratio, cost of cultivation and net return were calculated for crop and the cost of different items is given as a foot note in table 2.

RESULTS AND DISCUSSION

Effect on weeds

The prominent weed flora observed in weedy plots of the experiment were *Chenopodium album, Malva neglecta, Medicago denticulata, Solanum nigrum, Lepidium sativum, Trigonella polycerata, Melilotus* sp. and *Oenothera drumendii*.

The results revealed that weed population and dry matter accumulation of weeds were not significantly influenced by different planting patterns. However, from 60 days after transplanting upto harvest, bed planting with or without rice straw incorporation recorded lower weed population and lesser dry matter accumulation by weeds as compared to other treatments (Table 1). The lowest weed count and dry matter accumulation was recorded with application of oxyflourfen followed by pendimethalin and two hand weedings, which were statistically at par and significantly better than application of fluchloralin (Table 1). As would be expected, the unweeded control recorded the maximum count of weeds and dry matter accumulation, significantly higher than all weed control treatments at all the crop stages. Effectiveness of various herbicides against different weed species in onion has been earlier reported by Angaris and Kumar (2005). They also revealed that both the hand weeding as well as herbicidal treatments resulted in significant reduction in dry weight of weeds as compared to unweeded control. Among weed control treatments, during both years, maximum weed control efficiency (WCE) was observed with oxyflourfen being at par with pendimethalin and two hand weedings. The lowest WCE was recorded with fluchloralin. Similar results were found by Patel *et al*. (2011).

Yield attributes

All the planting patterns were found to be at par with respect to yield attributes viz., fresh weight and diameter of onion bulb (Table 2). However, the treatment of bed planting with rice straw incorporation produced highest fresh weight, which was followed by flat planting with rice straw incorporation, bed and flat planting without rice straw incorporation. Moreover, maximum diameter was obtained by bed planting than flat bed planting, without

Table 1. Periodic weed population, dry matter accumulation and weed control efficiency as influenced by planting patterns of onion and weed control treatment.

Treatment	Weed population/m²						Dry matter accumulation (g/m²)						Weed Control Efficiency (%) (At uprooting)	
	60 DAT		90 DAT		At uprooting		60 DAT		90 DAT		At uprooting			
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Planting patterns														
FBRI	3.5 (19.1)	3.1 (16.0)	3.9 (27.9)	3.9 (27.3)	3.9 (32.3)	4.3 (31.3)	2.4 (9.1)	2.2 (6.1)	3.7 (24.3)	3.3 (20.6)	4.1 (29.3)	3.8 (27.1)	-	
FB	3.6 (19.3)	3.2 (16.5)	4.0 (28.6)	3.9 (27.4)	3.9 (33.0)	4.4 (31.8)	2.6 (10.1)	2.5(7.5)	3.8 (24.6)	3.4 (21.7)	4.0 (29.2)	3.9 (28.1)		
RBRI	3.2 (16.4)	3.0 (13.9)	3.7 (26.3)	3.7 (24.0)	3.7 (31.8)	4.1 (28.5)	2.6 (8.1)	2.1 (5.9)	3.5 (21.3)	3.4 (19.6)	3.9 (27.2)	3.9 (26.1)		
RB	3.2 (16.0)	3.0 (13.1)	3.7 (26.6)	3.8 (24.4)	3.8 (31.9)	4.1 (28.4)	2.6 (8.0)	2.1 (5.8)	3.5(21.7)	3.5 (19.6)	3.9 (27.0)	3.9 (26.1)		
SEm±	0.16	0.27	0.18	0.10	0.11	0.15	0.10	0.18	0.26	0.10	0.20	0.10		
CD (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		
Weed control														
Pendimethalin	2.2 (2.8)	1.5 (1.4)	1.6 (3.3)	1.8 (2.5)	2.2 (3.9)	2.0 (3.3)	1.4 (1.1)	1.3 (0.8)	1.7 (1.9)	1.7 (1.9)	1.7 (2.1)	1.8 (2.2)	98.2	98.1
Oxyflourfen	2.2 (2.4)	1.6 (1.8)	1.5 (2.8)	1.7 (2.0)	1.9 (2.9)	1.1 (2.8)	1.4 (0.9)	1.3 (0.8)	1.6 (1.8)	1.5 (1.3)	1.7 (2.0)	1.7 (1.8)	98.3	98.4
Fluchloralin	3.4 (11.8)	2.9 (8.9)	3.9 (15.6)	3.6 (12.6)	4.7 (21.7)	4.2 (17.5)	2.6 (6.2)	2.3 (4.9)	3.0 (8.9)	2.7 (6.2)	4.2 (16.9)	3.6 (12.2)	85.8	89.5
Two hand weedings	2.4 (3.0)	1.6 (1.7)	1.8 (3.5)	1.9 (2.9)	2.1 (3.6)	2.1 (3.5)	1.4 (1.1)	1.4 (0.9)	1.7 (2.0)	1.7 (1.9)	1.8 (2.4)	1.8 (2.3)	97.9	98.0
Control (unweeded)	6.6 (65.9)	7.6 (58.1)	10.7 (114.1)	10.4 (108.1)	8.4 (130.5)	11.3 (128.0)	5.9 (34.7)	4.9 (24.1)	9.9 (98.1)	9.6 (90.7)	10.9 (119.1)	10.8 (115.7)	-	-
SEm±	0.32	0.29	0.34	0.27	0.25	0.27	0.28	0.29	0.24	0.19	0.22	0.18		
CD (P=0.05)	0.65	0.59	0.69	0.55	0.50	0.54	0.56	0.63	0.48	0.40	0.46	0.38		

Interaction: All interactions NS, Data is transformed to $\sqrt{X+1}$ values in the parenthesis are original values

FB- Flat bed; FBRI - Flat bed with rice straw incorporation; RB- Raised bed; RBRI- Raised bed with rice straw incorporation

consideration of rice straw incorporation. Sharma (2006) reported non significant differences in fresh weight under different planting patterns but the largest bulb were given by raised bed sowing than flat bed sowing.

The fresh weight and diameter of onion bulb recorded at 60, 90 days after transplanting and at harvest time was significantly higher under oxyflourfen which was statistically at par with pendimethalin and two hand weedings, but significantly superior to fluchloralin and unweeded control. These results are in accord with Tripathy *et al*. (2008). Application of oxyflourfen and pendimethalin resulted in less crop-weed competition throughout the growth stages (Murthy *et al*., 2007). Singh *et al*. (2001) and Sharma (2008) also reported that herbicidal treatments were quite effective in checking weeds growth, leading to significant increase in bulb diameter as compared to unweeded control.

Bulb yield

Bulb yield of onion crop was not significantly influenced with planting patterns during both the years of investigations (Table 2). However, rice straw incorporation did show some advantages. Application of crop residues and its subsequent decomposition in soil released plant nutrients in slow manner throughout the crop-growth period causing better nutrient availability and thus it increased the values of yield attributing characters of onion (Table 2), which ultimately reflected in increased yield of onion. Similar findings were reported by Sharma *et al* (2003).

Bulb yield of onion crop was significantly influenced by weed control treatments during both the years of study. Application of oxyflourfen gave the higher bulb yield, which was statistically at par with pendimethalin and two hand weedings. These treatments proved significantly better than fluchloralin and unweeded control treatment due to less intensity of weeds and better yield attributes. Nevertheless, bulb yield of onion in the treatment of fluchloralin was significantly better than unweeded control.

On an average, oxyflourfen gave the highest bulb yield of onion which was 5.9, 10.5, 29.1 and 78.9% more than pendimethalin, two hand weedings, fluchloralin and unweeded control, respectively. Murthy *et al.* (2008) also reported that hand weeding as well as herbicidal treatments resulted in higher yield than unweeded control.

Economics

From the economics point of view, the highest net returns (mean of 2 years) was obtained with flat sowing with rice straw incorporation (₹162.2×10³/ha) with

Table 2. Periodic fresh weight and diameter of onion bulbs as influenced by planting patterns on bulb yield (t/ha) of onion and weed control treatments (Pooled data of 2 years)

Treatment	Fresh weight (g)			Bulb diameter (cm)			Bulb yield (t/ha)	Cost of cultivation (×10³ ₹/ha)	Net returns (×10³ ₹/ha)	B:C ratio
	60 DAT	90 DAT	At uprooting	60 DAT	90 DAT	At uprooting				
Planting pattern										
FBRI	20.3	41.6	48.1	1.90	4.19	4.91	23.0	21.5	162.2	7.54
FB	17.8	40.5	45.8	1.86	3.94	4.74	21.4	20.8	150.2	7.21
RBRI	21.6	46.2	49.8	2.11	4.53	5.30	22.3	22.0	155.8	7.08
RB	18.3	42.1	46.3	2.00	4.44	5.18	20.8	21.1	144.8	6.86
SEm±	1.4	2.7	2.4	0.11	0.12	0.14	1.3	-	-	-
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	-	-	-
Weed control										
Pendimethalin	22.0	45.2	50.5	2.14	4.50	5.70	24.8	24.0	174.3	7.26
Oxyflourfen	23.5	46.9	52.1	2.24	4.64	5.79	26.3	24.3	185.6	7.63
Fluchloralin	17.6	40.1	44.4	1.85	4.09	4.58	20.3	20.4	138.6	6.79
Two hand weedings	21.5	46.5	49.2	2.08	4.39	4.99	23.8	24.4	165.5	6.77
Control (unweeded)	12.2	33.8	40.2	1.54	3.79	4.11	14.7	22.9	94.3	4.10
SEm±	1.5	2.5	2.6	0.14	0.14	0.19	1.4	-	-	-
CD (P=0.05)	3.1	5.0	4.8	0.28	0.28	0.38	2.9	-	-	-

Interaction: All interactions NS

FB- Flat bed; FBRI - Flat bed with rice straw incorporation ; RB- Raised bed ; RBRI- Raised bed with rice straw incorporation

Prevailing prices of inputs and outputs: FYM ₹1/kg; Labour ₹100/day; onion bulb ₹8/kg; Pendimethalin ₹360/litre; Oxyfluorfen ₹480/litre; Fluchloralin 330/litre; urea ₹5.57/ kg; SSP ₹4.21/kg; MOP ₹5.34/kg

benefit:cost ratio of 7.54, followed by bed planting with rice straw incorporation (₹155.8×10³/ha), flat sowing without rice straw incorporation (₹150.2×10³/ha) and bed planting without rice straw incorporation (₹144.8×10³/ha) with BCR 7.08, 7.21 and 6.86, respectively. Among the different weed control treatments, the maximum net returns of ₹185.6×10³/ha with BCR 7.63 registered with oxyflourfen. Unweeded control treatment recorded the lowest net returns of ₹94.3×10³/ha with BCR 4.10.

It is concluded that planting patterns had no significant effect on yield attributes and yield of onion and application of oxyflourfen @ 0.225 kg/ha followed by pendimethalin @ 0.75 kg/ha well controlled the weeds and were profitable for bulb crop of onion.

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