African Journal of Biotechnology Vol. 8 (3), pp. 412-416, 4 February, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

Planting time and mulching effect on onion development and seed production

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Accepted 16 January, 2009

A field experiment was conducted to evaluate effects of planting time and mulches on bulb growth and seed production of onion (*Allium cepa* L.) cv. Taherpuri. Planting time and mulches had significant influence on almost all parameters studied. Onion planted on 21 November had better agronomic traits contributing towards yield formation. Growth and seed production was accelerated by black polythene. Seed yield (460.81 kgha^{-1}) was highest in the plots planted on 21 Nov. Seed yield was 529.06 kgha^{-1} where black polythene mulch was used.

Key words: *Allium cepa*, mulch, planting time, seed production.

INTRODUCTION

Onion (*Allium cepa*) is a major bulbous crop among vegetables and is of global importance. Out of 15 vegetables listed by FAO, onion falls second only to tomato in terms of total annual world production (Pathak, 2000). Onion is extensively used as condiment in the preparation of curry, chutney and pickle. It is an indispensable part of the Bangladeshi diet and is commonly used both by rich and poor but domestic production does not achieve even 15% of the annual requirement (Hossain and Islam, 1994). In Bangladesh, the yield of onion seed varies from 370 to 500 kg ha^{-1} which is very low as compared to yield of 1,000 to 1,200 kg ha^{-1} in other countries of the world (Brewster, 1994). Low productivity of onion in Bangladesh could be attributed to limited availability of quality seed and lack of appropriate hybrids (Tomar et al., 2004; Ali et al*.,* 2007). The target of onion productions can not be achieved due to an acute crisis of onion seeds. Improved seed contributes substantially to enhance crop yield as high as 30% (Shaikh et al., 2002).

A lot of work has been conducted on onion bulb production but a little information is available on onion seed production. Yield and quality of onion seed is greatly affected by the soil fertility and environmental conditions during growth and development.

Soil moisture is an important factor that influences seed yield. Onions require frequent irrigations. Because they extract very little water from depths beyond 24 inches; most of the water is from the top 12 inches of soil. Thus upper soil areas must be kept moist to stimulate root growth and provide adequate water for the plant. Black and white polythene mulch or organic mulch are a reasonable expense and conserve soil moisture (Mukherjee et al., 2004). Polythene mulch also increases soil temperature and moisture especially in early spring. These synthetic mulches reduce weed problems and certain insect pests and also stimulate higher crop yields by more efficient utilization of soil nutrients (Rhu et al., 1990; Kashi, et al., 2004). Mulching with plant residues and synthetic materials is a well-established technique for increasing the profitability of many horticultural crops (Duranti and Cuocolo, 1989; Gimenez et al., 2002). Such effects are mainly contributed to the capacity of mulch to conserve soil moisture (Vavrina and Roka, 2000). The present work was undertaken to determine the proper planting time and to assess the effect of different mulches on growth of bulb and seed yield of onion.

MATERIALS AND METHODS

An experiment to optimize planting time and evaluate effect of Mulching on bulb development and seed production in onion was conducted at the Crop Botany Research Farm, Bangladesh Agri-

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cultural University, Mymensingh, during 2001-2002. Onion cultivar Taher-puri was chosen for the study because of its availability in the market. The experiment was laid out in a two factor split plot design with 3 replications keeping sowing dates (October 30, November 10, November 21) in main plots and mulches (black polythene, white polythene, water hyacinth and no mulch; control) in sub plots. Bulbs of uniform size (8-10 g) were planted with a spacing of 25 × 20 cm. Dimension of each and every individual plot was 1 x 1 m. Recommended dose of fertilizer (150-100-180 kg ha^{-1} NPK) in the form of urea, triple super phosphate and muriate of potash was applied to grow the crop. In addition to NPK, gypsum, zinc and borax were also applied at 20-3.7-1.7 $kgha^{-1}$. Nitrogen was applied in two splits, the first along with phosphorus and potash at the time of soil preparation while the remaining half was applied during apparent flowering and umbel formation of crops.

The experimental plots were thoroughly cultivated and leveled so as to minimize such protrusions as clods, stubble, and stones in the area and to prevent the tearing of polythene sheeting. Slight irrigation was given prior to laying of the polythene sheeting to make soil surface more uniform and to increase the moisture content. Mulches were laid in the plots after one weeks of planting onion bulbs when the seedlings were apparently visible. Two edges of polythene sheets were inserted in the furrows.

Hand hoeing was done periodically in control plots. Staking was provided for each plant to keep the flowering stalk erect. Harvest was initiated when about 10% of the black seeds were visibly exposed in the umbel. The mature umbels were harvested several times by cutting the flower stalk. Harvesting was done in the morning to minimize the shattering losses. After harvesting, seeds were dried to maintain its low moisture content (6-8%). Dried seeds were kept in sealed polythene bags stored with low storage temperatures which favour longer storage life.

Data were recorded on plant height, tillers per plant, leaves per plant, days to 50% flowering, length of scape, diameter of scape, number of flowers per umbel, number of seeds per umbel, weight of seeds per umbel, weight of thousand seeds and seed yield. Data so collected were analyzed statistically using analysis of variance technique (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Plant height

Differences in plant height were apparent from early growth stages to final harvest. At the final harvest, bulbs planted on 21 Nov. produced the tallest plants (47.74 cm), while the shortest plants (42.95 cm) were those planted on 30 Oct. The tallest plants were recorded in the plots covered with black polythene mulch followed by water hyacinth and white polythene mulch. Black polythene and water hyacinth covered plants did not differ significantly. Plant heights were significantly low in the bared or no-mulched plots (Table 1). This may be due to better water conservation for plants under the mulch than non-mulched plots (Opara-Nadi and Lal, 1987).

Tillers per plant

Number of tillers per plant (4.0) was maximum in 21 Nov. planted onion while minimum (3.68) was recorded in 30 Oct. planted plots. All mulches had the stimulatory effects in tillering compared to control at all the stages of plant growth (Table 1). The maximum tillers (4.63) were obtained from black polythene mulch followed by water hyacinth (4.49) but they are statistically identical. Tillers per plant was minimum (2.44) in non-mulched control plots. Onion is a poor competitor against weeds because of its slow growth, small stature, shallow roots, and lack of dense foliage. Reduction of weed infestation is an additional benefit of synthetic mulching. This could have been caused by direct thermal killing of weed seeds either before germination or soon after it had been induced by moisture in the mulched plots.

Number of leaves per plant

Leaf number per plant was gradually increased from 45 to 75 days after planting (Table 3) and then declined during final harvest (Table 1). This trend was obvious for all the treatments used. During final harvest, the highest number of leaves per plant (25.73) was counted in 21 Nov. planted crop followed by 10 Nov. (23.12) plantation while leaf number was least in 30 Oct. (22.97) planted onion (Table 1). There was no significant difference in the number of leaves counted in 30 Oct. and 10 Nov. planted onion plots. During counting the leaves, 21 Nov. planted onions were comparatively younger than other two treatments and senescence started only in the basal leaves. On the other hand, more dry leaves were observed in late Oct. and early Nov. planted onion. Favorable cool temperature and fully sunny days in the late November also promoted the maximum vegetative growth while the temperature at late October and early November was comparatively higher than 21 Nov. Moreover raining at late October and early November also caused excessive soil moisture and damaged vegetative growth.

Stimulatory effects of polythene sheets on the number of leaves were observed. In all the stages, the highest number of leaves per plant (27.07) was found in black polythene mulch, which was identically followed by water hyacinth (25.07) and white polythene mulch (23.80). However, the control treatment gave minimum number of leaves (18.48) per plant (Table 1). The number of leaves per plant gradually increased from 45 DAP to 75 DAP for all treatments (Table 3) and at final harvest it showed declining trend. Generally high nutrient availability induces greater number of leaves per plant. The higher nutrient availability in water hyacinth was well established by researchers (Baten et al., 1995). Duranti and Cuocolo (1989) also reported slight increase in the number of leaves due to application of mulch in onion. The increased number of leaves per plant might have been accompanied by taller plant.

Days to 50% flowering

Planting time and mulches had marked influence on the number of days required for emergence of 50% flower stalk (Table 1). The onion planted on 30 Oct. captured

Table 1. Effect of planting date and mulches on agronomic traits of onion.

Treatment	Plant height (cm)	Tillers per plant	Leaves per plant	Days to 50% flowering	Length of scape (cm)	Umbels per plant
Planting date:						
30 Oct.	42.95	3.68	22.97	50.34	57.46	3.54
10 Nov.	45.43	4.09	23.12	52.27	61.16	3.86
21 Nov.	47.74	4.40	25.73	54.04	64.55	4.21
LSD (0.01)	1.263	0.126	0.875	0.274	0.769	0.136
Mulches:						
Black polythene	43.76	4.63	27.07	50.50	63.64	4.49
White polythene	36.79	4.16	23.80	51.79	63.01	3.89
Water hyacinth	42.53	4.49	25.07	53.35	63.06	4.31
No mulch (control)	32.56	2.94	18.48	55.21	54.98	2.78
LSD(0.01)	1.453	0.145	1.283	0.317	0.325	0.157

the longest time (54.04 days) while 21 Nov. planted onion took the shortest time (50.34 days) for 50% flowering. Mulching reduced mean time to 50% flowering. The flowering period was reduced by 5 days for black polythene mulch and by 3 days for white polythene mulch. Among the mulch treatments, the plants grown with the black polythene mulch took shortest time (50.50 days), which was identically followed by water hyacinth (53.35 days) and white polythene mulch (51.79 days). However, the longest time period was required for control treatment (55.21 days). Early flowering is an indicator of early maturity. Sometimes early maturing is good as it can escape from bad weather and diseases.

Length of scape

The maximum scape length (64.55 cm) was recorded in 21 Nov. planted onion while the minimum length (57.46 cm) was found in 30 Oct. planting date. Significant influence in scape length was also recorded in mulching treatments. The maximum scape length (63.64 cm) was obtained from black polythene mulch which was statistically similar with that of water hyacinth mulch (63.06 cm) and white polythene mulch (63.01 cm), whereas non-mulched plants produced the minimum (54.98 cm) scape length. Abu-Rayyan and Abu-Irmaileh (2004) also reported that onion requires cool weather during inflorescence initiation and seed stalk development. A moderately high temperature and dry weather conditions are favourable for seed maturation.

Number of umbels per plant

Number of umbels per plant was highest (4.21) in 21 Nov. planting date while the lowest at 30 Oct. planting of mother bulbs. On the other hand, the highest number of umbels per plant (4.49) was observed in plots covered with black polythene mulch followed by the water hyacinth (4.31) and white polythene mulch (3.89). The lowest number of umbels per plant (2.78) was observed when no mulch was used.

Number of flowers per umbel

The number of flowers per umbel is a very important component contributing to final seed yield. The means reported in Table 3 revealed significant variations in the number of flowers per umbel due to different planting dates and mulching. The highest (239.0) number of flowers per umbel was produced from 21 November planting while the lowest number (194.6) was recorded in 30 Oct. planted onion. Among the mulches, black polythene mulch produced the highest number of flowers per umbel (243.37) followed by water hyacinth (227.53) and white polythene mulch (218.64), which were statistically different. The lowest (179.94) number of flowers per umbel was recorded in the control. Treatment combination of black polythene mulch with 21 Nov. planting date gave highest number of flowers per umbel (262.8) while control treatment with 30 Oct. planting date recorded the lowest (160.9).

Number of seeds and seed set (%) per umbel

Significantly highest (171.1) numbers of seeds per umbel were recorded in the 21 November planted onion. Consequently seed set percent in each umbel was also highest in same planting date (77.38 %). Significantly lowest values for both numbers of seeds per umbel and seed sets per umbel were observed in the 30 October planted onion. Number of seeds per umbel and percent seed set was 139.6 and 68.28%, respectively. Significant variation was found due to the effect of mulching on both number of seeds and percent seed set per umbel (Table 2). Maximum number of seeds per umbel (175.52) was obtained from the plants grown with black polythene mulch and the minimum (116.54)

Table 2. Effect of planting date and mulches on reproductive development of onion.

Treatments	Flowers per umbel	Seeds per umbel	Seed set (%)	Seed yield				1000-seed weight (g)	Germination (%)
				g per umbel	g per plant	g per plot	kg ha^{-1}		
Planting time:									
30 Oct.	194.63	139.64	68.28	0.46	1.75	36.01	355.7	3.07	71.87
10 Nov.	218.47	154.71	72.08	0.51	2.06	41.78	415.8	3.26	80.10
21 Nov.	239.00	171.12	77.38	0.56	2.30	46.41	460.8	3.48	85.41
LSD (0.01)	8.590	5.244	2.103	0.016	0.063	1.549	12.83	0.109	5.323
Mulches:									
Black polythene	243.37	175.52	76.56	0.58	2.64	54.13	529.1	3.34	83.90
White polythene	218.64	159.28	73.07	0.54	2.13	43.12	419.3	3.29	80.50
Water hyacinth	227.53	169.29	73.51	0.55	2.35	48.29	479.0	3.34	82.31
No mulch (control)	179.94	116.54	67.17	0.35	1.01	20.05	203.6	3.11	69.59
LSD (0.01)	9.919	6.055	2.428	0.018	0.072	1.788	13.35	0.126	4.632

Table 3. Combined effect of planting time and mulches on the yield and yield contributing characters of onion.

Planting time	Mulch	Number of leaves per plant			Flowers per umbel	Seeds per umbel	Seed yield g per plant	Germination (%)
		45 DAP	60 DAP	75 DAP				
30 Oct.	BP	21.31	25.48	30.21	221.57	164.86	2.35	75.78
	WP	18.33	22.53	25.70	183.22	133.99	1.88	73.56
	WH	20.25	24.29	28.52	212.80	158.88	1.98	75.19
	NM	13.53	15.56	18.72	160.94	100.86	0.78	62.94
10 Nov.	BP	22.62	26.26	31.39	245.73	174.64	2.70	82.31
	WP	19.45	23.32	28.41	227.39	165.10	2.12	81.59
	WH	20.37	24.43	29.49	221.81	164.56	2.40	83.48
	NM	14.76	18.46	23.78	178.96	114.52	1.03	72.27
21 Nov.	BP	25.17	29.46	33.51	262.82	187.74	2.90	93.60
	WP	21.65	25.53	29.46	245.29	178.74	2.40	86.35
	WH	22.70	26.48	30.31	247.97	184.42	2.68	88.26
	NM	17.67	21.42	25.23	199.93	134.25	1.24	73.42
LSD (0.01)		0.770	0.705	0.646	17.18	10.49	0.126	4.140

NM, No mulch; BP, Black polythene; WP, White polythene; WH, Water hyacinth; DAP, Days After Planting.

was from the control plot. Water hyacinth and white polythene mulch treated plants gave 169.29 and 159.28 seeds per umbel respectively. Same trend was observed in seed set per-cent per umbel due to synthetic mulches.

Seed yield

Bulb planting dates had significant effect on seed yield per umbel, per plant, per plot and per hectare. The highest yield was obtained from 21 Nov. planted onion. These were 0.55 g per umbel, 2.30 g per plant, 46.40 g per plot, and 460.8 kg ha^{-1}, respectively and the lowest was recorded in 30 October with respective values of 0.45 g per umbel, 1.74 g per plant, 36.01 g per plot and 355.7 kg ha^{-1}. Mulching markedly increased seed yield of onion irrespective of planting dates.

These increases were greater in black polythene mulch than the other mulches. Improved seed yields resulted from increased number of umbels and flowers per umbel. The highest seed yield per hectare (529.1 kg) was observed with black polythene mulch followed by water hyacinth (479.0 kg) while the control plant produced very low yield (203.6 kg) in comparison to mulch treated plants.

1000-seed weight

Date of planting had also significant effects on the quality of produced seed. The heaviest seed (3.48 g) was obtained from 21 Nov. planted onion and the lowest weight (3.07 g) was obtained from 30 Oct. planted bulb.

Significant influence of mulching on 1000 seed weight over control was observed. All the mulching treatments recorded statistical similar weight of the seeds that was in the range of 3.34-3.29 g. The controls produced minimum (3.11 g) weight of 1000-seeds.

The onion mother bulb planted on21 Nov. with black polythene mulch gave the highest results number of seeds per umbel (187.74%), seed set (81.53%), seed yield per umbel (0.65 g), seed yield per plant (2.90 g), seed yield per plot (60.25 g), seed yield per hectare (593.18 kg), thousand seed weight (3.61 g), and germination percentage (93.60%). Lowest seed yield (161.43 kg ha^{-1}) was found in the control with 30 Oct. planting combination and the lowest germination (62.94%) was recorded from the combination of control with 30 Oct. planting.

Percent germination

Significant variation was observed in case of onion seed germination due to both different planting dates and different mulches applied. Germination percent (85.41%) was the highest in the seeds collected from the 21 Nov. planted onion while this value was the lowest (71.87%) in the 30 Oct. planted onion. This variation was due the seed size and their food reserves which enhances the germinated of the seeds. Significant influence of mulches on germination percentage was also recorded. The highest germination (83.90%) was observed from black polythene mulch followed by the water hyacinth (82.31%) that was statistically similar with each other. White polythene mulch gave 80.50% germination, which was statistically similar with water hyacinth mulch. The lowest germination percentage (69.54%) was found from non-mulch treatment (Table 2).

Conclusion

The results of this experiment showed that planting dates vary in their influence on bulb growth and seed production of onion. Among the planting dates studied, 21 Nov. was the more suitable than other two. Mulching materials also varied in their effectiveness on onion seed production. Among the mulches used, black polythene mulch gave higher growth and seed yield of onion. However, further investigations are needed in different regions before recommending these practices for use.

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