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PERFORMANCE OF GARLIC BULB PRODUCTION UNDER ZERO TILLAGE MULCHED CONDITION AS AFFECTED BY TIME OF WEEDING

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ABSTRACT

An investigation was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna during 2008-2009 and 2009-2010 to find out the suitable time of weeding for higher yield of garlic under zero tillage mulched condition. Five treatments viz., No weeding = T_1, Weeding at 25 and 45 DAE = T_2, Weeding at 45 and 65 DAE = T_3, Weeding at 25, 45 and 65 DAE = T_4 and Weed free = T_5 were included in a RCB design with three replication. In both the year weed free treatment gave the highest bulb yield (8.46 t/ha in 2008 and 8.92 t/ha in 2009). Weeding at 25, 45 and 65 DAE was suitable for better yield of garlic in respect of gross margin (358823 Tk./ha) and benefit cost ratio (3.98). The maximum yield reduction was noticed in no weeding (70.22-72.20%) over weed free treatment. *Ipomea sp, xanthium indicum* and *cyperus rotundus* were found the most dominant species of weeds in the garlic field in both the years. Yield of garlic was negatively correlated with weed infestation (r= -0.94).

Key words: *Garlic, zero tillage, mulching and weed infestation*

INTRODUCTION

Garlic (*Allium sativum* L.) belongs to the family *Alliaceae* and genus *Allium*, and is a shallow rooted spices crop (Purseglove, 1992; Hanelt, 1990). It is an important spices ranking the second both in acreage and production among the spices and covering the area of about 33634 ha and production of 144817 mt in Bangladesh (BBS, 2009). The nutritional point of view, fresh peeled garlic clove (bulblets) contains 62.8% moisture; 6.3% protein; 0.1% fat; 1.0% mineral matter; 0.8%fibre; 29.0% carbohydrates; 0.3% calcium; 0.31% phosphorus; 0.001% iron and 13mg/100g vit.C (Pruthi,1976). It is generally cultivated through conventional methods of land preparation with irrigation as a cash crop in Bangladesh. Farmers of Challan bill area cultivate garlic after harvesting of T-aman rice. So, it takes few to more days for land preparation which causes late planting of garlic as well as yield reduction. To reduce the turn around time it can be cultivated under zero tillage condition on the muddy soil surface through straw mulching. Soil moisture conservation is the prime factor for crop cultivation under zero tillage condition. Straw mulching may play a great role in soil moisture conservation. Miko *et al*., 2000 and Bello, 2001 reported that, garlic is sensitive to moisture stress and high temperature and about 60% reduction in yield has been associated with water stress. Its growing period lasts from the month of November to April. The yield of garlic under zero tillage mulched condition is about 7-8 t/ha (DAE, 2004). Weed is a major constraint in garlic production under zero tillage mulched condition. Weeds compete with garlic for their nourishment through rapid growth and development by quick root and shoot development than crop. Weeds growing in association with the crop utilize considerable amount of nutrients and deprive the crop of expressing its yield potential (Rahman and Gaffer, 1986). Generally weed infestation occurs by *Ipomea sp*., *Xanthium indicum* and *Cyperus rotundus* in the garlic field at Chalan bill area of Bangladesh. But farmers do not follow any proper

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weed management practices resulting in higher yield loss. Bulb yield of garlic losses of about 79-89% due to weed infestation have been reported by Ahmed (1991). There is a critical weed competition period for every crop when the weeds cause maximum damage by competiting with the crop plants (Nicto *et al*., 1968; Shahota and Govinda, 1982). Weed control in suitable time enhance vegetative growth and development of the garlic plants which contributes to better yield. Hence, it is needed to know the proper time of weeding for better growth and yield of garlic under zero tillage mulched condition. Therefore, the present study was undertaken to find out the suitable time of weeding for higher yield of garlic under zero tillage mulched condition.

MATERIALS AND METHODS

The experiment was conducted at the Regional Agricultural Research Station, Ishurdi, Pabna, during 2008-2009 and 2009-2010. The experiment was laid out in randomized complete block design with 3 replications. The treatments were No weeding = T_1, Weeding at 25 and 45 DAE = T_2, Weeding at 45 and 65 DAE = T_3, Weeding at 25, 45 and 65 DAE = T_4 and Weed free = T_5. The unit plot size was 4m × 5m. Local garlic variety was used as the test crop. The crop was planted in line, maintaining 15 cm x 10 cm spacing on the muddy soil just 2 to 3 days after harvesting T-aman rice. Then the muddy soil surface was covered by rice straw. Planting was done manually using one clove per hole. The crop was planted on 10 November in 2008 and 14 November in 2009 and harvested on 2 April in 2009 and 10 April in 2010. The crop was fertilized with 155-35-125-20 kg N-P-K-S /ha. One third nitrogen was applied as basal and two third was top dressed in two equal installments at 25 and 50 days after planting. Other fertilizers were applied on the muddy soil as basal before planting and covering the soil surface by rice straw. Weeding was done as per treatment. Weed infestation per square meter, kinds of weed species, dry weight of weed were recorded from each of the treatments. Data on yield and yield components were recorded and analyzed statistically. Values were adjusted by LSD at 0.05 level of probability. Weed parameters like weed density, absolute density, relative density and intensity of weed infestation were computed from the above data using the following formula (Bhandari, 1981).

Weed density (D): It indicates the total number of individuals for all weed species per unit area (m^2)

Absolute Density (AD): It denotes the total number of individuals of a given weed species per unit area (m^2)

$$\text{Relative density (RD)} = \frac{\text{Absolute density of a given species}}{\text{Total absolute density for all species}} \times 100$$

$$\text{Intensity of weed Infestation (IWI) of a weed Species} = \frac{\text{Absolute density of a given weed species}}{\text{Absolute density of crop plants}}$$

$$\text{Intensity of weed Infestation (IWI) of total weeds Species} = \frac{\text{Weed density per squire meter}}{\text{Density of crop plants per squire meter}}$$

RESULTS AND DISCUSSION

Effect of weed infestation and dry mater of weed

Weed species, absolute weed density, relative weed density and intensity of weed infestation in different treatments have been presented in Table 1. The number of weed per meter squire ranged from 46.12 to 115.39 and 41.00 to 102.00 among the treatments during 2008-2009 and 2009-2010, respectively. The maximum number of weed was found in T_1 (115.39 and 102.00/m^2) where *Ipomea sp* showed higher infestation. The lowest number of weed infestation was recorded in T_4 (46.12 and 41.00/m^2) in both the years. The weed species *Ipomea sp*, *Xanthiam indicum* (Ghagra) and *Cyperus*

rotundus (Mutha) were found common in all the treatments. *Ipomea sp* was the dominant species among all other weed species in respect of relative density irrespective of all treatments (Table 1.). It is also prominent in respect of absolute density and intensity of weed infestation. Out of total 1.99 and 1.75 weeds competed with one garlic plant, 0.62 and 0.66 belonged to *Ipomea sp* with T_1 (No weeding) during 2008-2009 and 2009-2010, respectively. Similarly, 1.32 and 1.25, 1.32 and 1.24, 0.73 and 0.67 weeds competed with one garlic plant. Out of them, 0.45 and 0.43, 0.48 and 0.53, 0.19 and 0.24 belonged to *Ipomea sp* recorded in T_2 (Weeding at 25 and 45 DAE), T_3 (Weeding at 45 and 65 DAE) and T_4 (Weeding at 25, 45 and 65 DAE), respectively in both the years (Table 1).

Table 1. Infesting weed species, weed density, relative density and intensity of weed infestation during 2008-09 and 2009-10 cropping season

Treat.	Weed species	Absolute density (No. /m^2)		Relative density (%)		Intensity of weed infestation of a weed Species		Intensity of weeds infestation of total weeds Species	
		2008-2009	2009-2010	2008-2009	2009-2010	2008-2009	2009-2010	2008-2009	2009-2010
	Ipomea aquatica (Ipomea sp).	36.5	38.29	31.63	37.53	0.62	0.66		
	Cynodon dactylon (Durba)	26.15	25.34	22.66	24.84	0.45	0.43		
	Cyperus rotundus (Mutha)	28.70	26.00	24.87	25.49	0.49	0.44		
T_1	*Desmodium trifolium* (tripatrisak)	9.30	4.22	8.05	4.13	0.16	0.07	1.99	1.75
	*Xanthium indicum (*Ghagra)	9.42	4.56	8.16	4.47	0.16	0.07		
	Other	5.32	3.59	4.61	3.51	0.09	0.06		
	Total	115.39	102.00	-	-	-	-		
	Ipomea aquatica (Ipomea sp.)	28.36	26.13	34.46	34.57	0.45	0.43		
	Cynodon dactylon (Durba)	10.56	14.33	12.83	18.96	0.17	0.23		
	Cyperus rotundus (Mutha)	22.72	20.44	27.61	27.04	0.36	0.34		
	Desmodium trifolium (tripatrisak)	8.72	4.00	10.59	5.29	0.14	0.06	1.32	1.25
	Xanthium indicum (Ghagra)	7.34	4.34	8.92	5.74	0.11	0.07		
T_2	Other	4.58	6.35	5.56	8.40	0.07	0.10		
	Total	82.28	75.59	-	-	-	-		
	Ipomea aquatica (Ipomea sp.)	29.0	32.32	36.53	43.25	0.48	0.53		
	Cynodon dactylon (Durba)	14.27	12.21	17.97	16.34	0.23	0.20		
	Cyperus rotundus (Mutha)	20.39	17.00	25.68	22.75	0.33	0.28		
	Desmodium trifolium (tripatrisak)	6.14	5.50	7.73	7.36	0.10	0.09	1.32	1.24
	Xanthium indicum (Ghagra)	5.31	3.70	6.69	4.95	0.08	0.06		
T_3	Other	4.26	3.99	5.36	5.33	0.07	0.06		
	Total	79.37	74.72	-	-	-	-		
	Ipomea aquatica (Ipomea sp.)	12.17	14.77	26.38	36.02	0.19	0.24		
	Cynodon dactylon (Durba)	10.19	7.88	22.09	19.21	0.16	0.12		
	Cyperus rotundus (Mutha)	10.23	12.00	22.18	29.26	0.16	0.19		
T_4	*Desmodium trifolium* (tripatrisak)	4.10	-	8.88	-	0.06	-	0.73	0.67
	Xanthium indicum (Ghagra)	4.22	2.7	9.15	6.58	0.06	0.04		
	Other	5.21	3.65	11.29	8.90	0.08	0.05		
	Total	46.12	41.00	-	-	-	-		

T_1= No weeding,
T_2= Weeding at 25 and 45 DAE
T_3= Weeding at 45 and 65 DAE
T_4=Weeding at 25, 45 and 65 DAE

In visual field observation *Xanthiam indicum* (Ghagra) showed higher canopy architecture although it produced the lower relative density. On the other hand, *Cyperus rotundus* (Mutha) ranks second in terms of intensity of infestation. Holom (1969) reported from India that *Cyperus rotundus* (Mutha) was the most notorious weed of upland crops. In field observation the *Ipomea sp* grown very fast and rolled the plant quickly and finally covered the whole plot within a few days. In such competition, probably photosynthesis of garlic plant is hampered resulting poor crop growth and lower yield.

The weed dry meter increased gradually with the advancement of time in control plot (Table 2). Among the treatments T_1 (No weeding) produced the highest weed dry weight (17.17, 26.56, 47.81 and 80.26g in 2008-2009 and 18.97, 28.66, 51.24 and 90.06g in 2009-2010 per meter squire) at 40, 60, 80 DAE and at harvest, respectively due to its highest intensity of infestation and the lowest in T_4 (Weeding at 25, 45 and 65 DAE).

Table 2. Weed dry weight (g/m^2) as influenced by time of weeding during 2008-09 and 2009-10

Treatments	Weed dry weight (g/m^2)							
	2008-2009				2009-2010			
	40 DAE	60 DAE	80 DAE	At harvest	40 DAE	60 DAE	80 DAE	At harvest
T_1	17.70	26.56	47.81	80.26	18.97	28.66	51.24	90.06
T_2	7.32	11.99	20.79	46.92	7.85	11.78	21.02	37.54
T_3	8.91	11.86	21.36	45.77	8.77	11.65	20.98	41.00
T_4	6.12	9.18	16.54	27.12	5.34	8.02	14.44	32.94
T_5	-	-	-	-	-	-	-	-

Effect of time of weeding on the yield component and yield of garlic

Yield component and yield of garlic under zero tillage mulched condition were significantly influenced by the treatments in both the years (Table 3). The maximum plant population (64 in 2008-2009 and 63 in 2009-2010) was observed in T_5 which was identical to all other treatments except T_1 (no weeding) in both the years. The tallest plant (53.92cm in 2008-2009 and 55.82cm in 2009-2010) was obtained from T_5 which was identical to T_4 in both the years. The maximum number of clove per bulb were recorded from T_5 (17.88 and 18.27) which was identical to T_4 in 2008-2009. In 2009-2010, T_5 showed highest which was statistically similar with T_2 and T_4 treatments in case of clove/bulbs. The bulb weight/plant was observed highest in T_5 (15.34-16.17g) followed by T_4 (14.67-14.66g) while the lowest in T_1 (10.83-11.80g) in both the years, respectively. The weight of 100-clove showed the similar trend like bulb weight/plant. The highest bulb yield was recorded in T_5 (8.46-8.92 t/ha) which was almost similar with T_4 (7.92-8.05 t/ha) while the lowest in T_1 (4.97-5.18 t/ha) in 2008-2009 and 2009-2010. Possibly after weeding at 25, 45 and 65 DAE, weeds were unable to show any effect on the bulb yield of garlic under zero tillage mulched condition. The highest bulb yield reduced in T_1 (70.22-72.20%) exhibiting a decreasing trend from T_2 to T_4 (26.45-6.81%) in both the years.

Cost and benefit analysis

Economic analysis of different treatments are presented in Table 4. The highest gross return (521400 Tk./ha) was observed in T_5 followed by T_4 (479100 Tk./ha) but its gross margin (355400 Tk./ha) and benefit cost ratio (3.14) were lowest than T_4 (gross margin 358823 Tk./ha and BCR 3.98) because labour cost for keeping weed free was much higher in T_5 compared to T_4. While the lowest gross return (304500 Tk./ha), gross margin (206723 Tk./ha) and BCR (3.11) were obtained from T_1 (No weeding).

Table 3. Yield and yield contributing characters of garlic as affected by weed infestation during 2008-09 and 2009-10

Treat.	Plant population (no. /m^2)	Plant height (cm)	Clove/ bulb (no.)	Bulb weight/plant (g)	100-clove weight (g)	Yield (t/ha)	Percent reduction of yield*
			2008-09				
T_1	58	40.83	10.50	10.83	70.56	4.97	70.22
T_2	62	50.00	15.17	14.00	82.85	6.89	26.45
T_3	60	47.83	14.82	14.00	82.14	6.74	29.35
T_4	63	51.60	16.20	14.67	84.96	7.92	6.81
T_5	64	53.92	17.88	15.34	90.17	8.46	-
CV (%)	3.31	3.43	8.02	6.66	3.60	7.60	-
$LSD_{(0.05)}$	3.83	3.15	2.25	1.72	5.56	0.99	-
			2009-10				
T_1	58	44.33	13.26	11.80	92.06	5.18	72.20
T_2	60	51.07	16.26	14.33	98.80	7.18	24.23
T_3	60	50.40	15.93	13.66	101.10	7.01	27.27
T_4	61	54.53	18.06	14.66	111.20	8.05	10.80
T_5	63	55.82	18.27	16.17	113.20	8.92	-
CV (%)	2.98	4.15	7.15	7.75	2.84	9.59	-
$LSD_{(0.05)}$	3.40	3.99	2.20	2.06	5.52	1.31	-

*yield reduction was estimated based on the yield obtained in T_5 (Weed free).
T_1= No weeding, T_2= Weeding at 25 and 45 DAE, T_3= Weeding at 45 and 65 DAE, T_4= Weeding at 25, 45 and 65 DAE, T_5= Weed free

Table 4. Economic analysis of different treatments (Average of two year's data)

Treatments	Gross return (Tk/ha)	Total variable cost (Tk/ha)	Gross margin (Tk/ha)	Benefit cost ratio
T_1	304500	97777	206723	3.11
T_2	422100	112777	309323	3.74
T_3	412500	112927	299573	3.65
T_4	479100	120277	358823	3.98
T_5	521400	166000	355400	3.14

Price: Garlic bulb = Tk 60/kg (as consumption), Tk 120/kg (as seed), Labour: Tk. 150.00/day

Functional relationship of weed infestation with bulb yield of garlic

Bulb yield of garlic was negatively correlated with weed infestation (r = -0.94) in both the years (Fig 1). Yield response of garlic to weed infestation was determine by the regression equation, $Y=8.4513 + 0.0018x - 0.0003x^2$ in 2008-2009 and $Y=8.8528 + 0.0006x - 0.0003x^2$ in 2009-2010. The equation showed that bulb yield decreased at the rate of 0.0018 t/ha in 2008-2009 and 0.0006 t/ha in 2009-2010 with increase of 1 weed m^{-2}. Co-efficient of determination (R^2) of 0.9945 in 2008-2009 and 0.9805 in 2009-2010 explained that bulb yield of garlic is influenced by 99%, 98 % due to weed infestation (Fig 1).

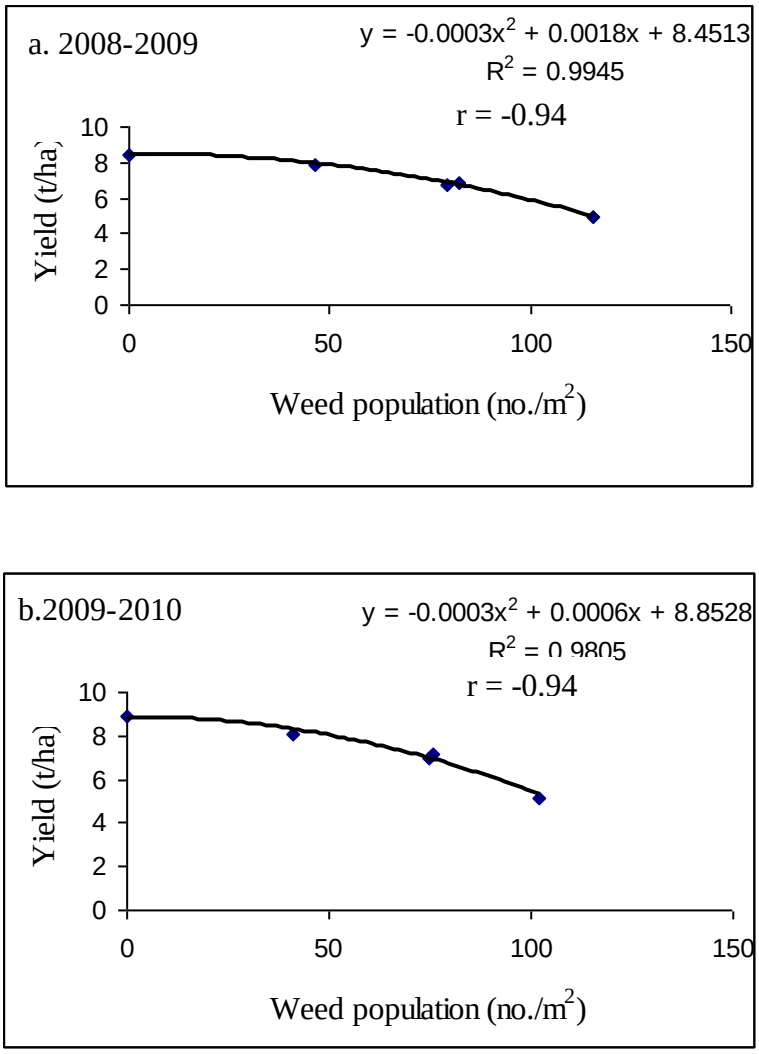

Figure 1. Functional relationship between weed infestation and bulb yield of garlic under zero tillage mulched condition (a. 2008-2009 and b.2009-2010)

CONCLUSION

From two years results, it may be concluded that for higher bulb yield, minimum weed infestation and maximum profit (in respect of gross margin and benefit cost ratio), weeding at 25, 45 and 65 DAE should be adopted under zero tillage mulched condition.

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