International Scholars Journals

International Journal of Irrigation and Water Management ISSN 2756-3804 Vol. 11 (1), pp. 001-008, January, 2024. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Enhancing water efficiency and weed management in baby corn cultivation through plastic mulching

Gulshan Mahajan*, Rakesh Sharda, Ashwani Kumar and K.G. Singh

Department of Soil and Water Engineering, Punjab Agricultural University, Ludhiana, India – 141004

Accepted 5 November, 2023

Field experiments were conducted during the winter season of 2003 -04 and 2004 -05 to determine the effect of mulch in relation to irrigation and planting method on soil temperature, weed control, baby corn growth, water use and yield. The study revealed that bed planting of baby corn caused 34.9% increase in yield over ridge planting method. Plastic mulch increased baby corn yield by 18.9% and 77.5% over rice straw and unmulched treatment respectively. Baby corn yield at irrigation level of 1.2 ETc proved significantly superior to 1.0 ETc and 0.8 ETc levels. The study further revealed that plastic mulch at irrigation level of 0.8 ETc resulted significant increase in yield by 28.6% over unmulched soil condition even when it was irrigated at 1.2 ETc and resulted 30.6% of water saving. It was interesting that in bed planting method, plastic mulch caused statistically same baby corn yield at all the levels of irrigation with maximum water use efficiency of 40.1 kg/ha-cm at irrigation level of 0.8 ETc, while in ridge planting method the baby corn yield was statically same only at irrigation level of 1.2 ETc and 1.0 ETc, while at 0.8 ETc it decreased significantly.

Key words: Baby corn, irrigation, plastic mulch, planting method, weeds, water use efficiency, soil temperature.

INTRODUCTION

Babycorn is a dehusked maize ear harvested within 2 - 3 days of silk emergence, but prior to fertilization (Pandey et al., 2002). Baby corn is used in preparing a wide variety of traditional and intercontinental dishes, besides being canned. Good quality green fodder is a bye product of it and would boost dairy farming. Baby corn cultivation pro- vides avenues for crop diversification, value addition and revenue generation. Being a widely spaced crop, it suffers heavy yield loss due to severe competition offered by weeds. Besides this, poor germination, scanty rainfall and slow growth in winter season are major limiting factors to quality and early production of baby corn for premium market. Timely irrigation is an important input for good quality of baby corn. So cultivation of crop demands efficient ways of utilizing any water reserves available to plants as the water requirement of the crop is high. Evaporation from the soil surface may account for as much as 50% of the total moisture lost from the soil during the gro wing season for soybean and corn (Shaw, 1959). In this context, 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) and increase early soil temperature (Shaw, 1959). It is clear that future increase in food productions which are required to keep pace with the escalating world population must be achie-ved without depleting our natural resource base of soil, water and air. Probably the greatest issue in maintaining sustainable agricultural production over the next few dec-ades will be the availability of water. Irreplaceable water supplies are already being used at an alarming rate as a result water table is going down day by day, and the agri-culture is increasingly competing with urban and Indus-trial water requirements. Moreover, excessive use of herbicides for the control of weeds had led to the problem of herbicide resistance in many crops. In this context, mulching may prove beneficial for crop growth because of complex change in soil environment through modifying soil tempe-rature, reduction in evaporation, weed competition, soil compaction and erosion. Considering the agricultural importance, the work done on the influence of mulches

*Corresponding author. E-mail:mahajangulshan@rediffmail.com

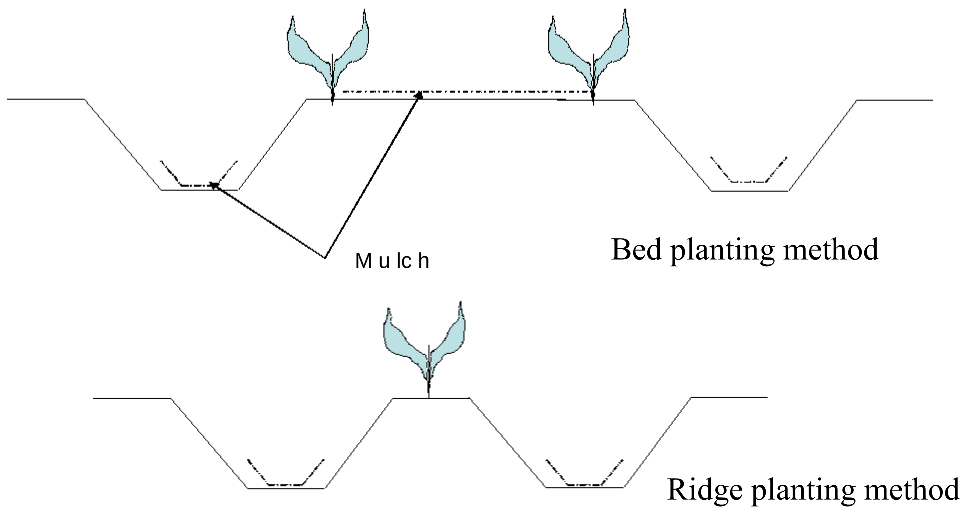

Figure 1. Illustration showing the bed planting method and ridge planting method with mulch.

on soil, water and weed management in baby corn growth is scanty. Therefore, the study was planned to determine the effect of mulches in relation to planting method and irrigation on soil temperature, water use, plant growth, weed control and baby corn yield.

MATERIALS AND METHODS

The field experiments were conducted during the winter season of 2003-04 and 2004- 05 at experimental farm, Department of Soil & Water Engineering ($30^0 56^/$ N, $75^0 56^/$E, 247 m above sea level) Punjab Agricultural University, Ludhiana, India. The soil of experimental site was sandy loam in texture, neutral in reaction, low in available N, medium in available P and K. Eighteen treatments replicated 3 times were used in split plot design with combination of method of planting (Bed and Ridge) and mulching treatments (Plastic mulch, Rice-straw mulch and No mulch) as main plots and irrigation scheduling treatments (1.2, 1.0 and 0.8 ETc) as sub plots. In all four rows of baby corn were sown in each plot having dimension of 6 m x 2.4 m. In bed planting method, baby corn seeds were sown at 80.0 cm wide bed in a paired rows pattern with row-to-row spacing of 50 cm. In ridge planting method, baby corn seeds were sown on ridge with row-to-row distance of 60 cm. The illustration is shown in the Figure 1.

The plant to plant spacing in both the methods of sowing 10 cm. Pratap cultivar of baby corn was sown with seed rate of 50 kg/ha in the first week of November in both the years. The crop was uniformly fertilized with recommended dose of N (125 kg/ha), P (26.4 kg/ha) and K (30.0 kg/ha) through urea, DAP and muriate of potash respectively. Half of the nitrogen and full P & K fertilizer were applied at sowing. Remaining N was top dressed 30 days after sowing. After planting, black plastic film of 25 μ thickness and 20 cm wide was placed in each furrow of plastic mulched treatment in such a way that 50% area of furrow remains open, so that water can enter through this. In bed planting method under plastic mulch treatment 40 cm wide sheet of same plastic film was also placed in between the two-paired rows. In rice straw mulched treatments, mulching was done immediately after planting at the rate of about 4 tons of rice-straw/ha, which gave a 1cm thick cover over the surface. The material covered the inter row soil surface to a depth of about 1 cm.

For the establishment of crop, one common irrigation of 72 mm depth was given to all the treatments at 8 days after sowing. Further irrigation was done as per the respective treatments by keeping the same water depth of 72 mm. It means in treatments 1.2, 1.0 and 0.8 ETc, the irrigation was done at 60, 72 and 90 mm of pan evaporation respectively. The cumulative pan evaporation was calculated as a sum of daily-recorded evaporation from USDA class A pan evaporimeter. Soil temperature was measured at 7.5 cm depth in the row by soil thermometer for all treatments. Temperature was rerecorded at 8 a.m. (minimum temperature) and at 2:30 (maximum temperature) each day. Green cobs were picked up next day of silk emergence and baby corn yield from each plot was recorded after dehusking. Ten baby corn cobs, from each plot were chosen at random for recording the average length, girth and weight of baby corn. Numbers of baby corns/plant were recorded from the average of 10 random plants from each plot. The crop received 88 mm rainfalls in the first year and 153.3 mm rainfall in the second year.

RESULTS AND DISCUSSION

Mulch and soil temperature

Soil temperature under different mulch treatments was recorded in relation to planting method and irrigation levels and then averaged under different mulch treatments. Since treatment effects on soil temperature were similar for both the year of study, only characteristics value for the first year is given (Table 1). Minimum soil temperature was raised by black plastic mulch by as much as 7^0C in the month of February. The maximum soil temperature under plastic cover was as much as 3^0C lower than those of unmulched soil. It was also observed that rice straw mulch caused decrease in maximum temperature by almost 1^0C, but increased the minimum temperature by 4.9^0C particularly in the month of February, so also proved good but inferior than the plastic mulch in view of desirable range of temperature. Temper-

Table 1. Air temperature at height of 1 meter, maximum and minimum soil temperature at depth of 7.5 cm with andwithout plastic and rice straw mulch treatments in 2003-04.

Date	**Maximum temperature (^{0}C)**				**Minimum temperature (^{0}C)**			
	Air	**Bare soil**	**Plastic covered soil**	**Rice straw covered soil**	**Air**	**Bare soil**	**Plastic covered soil**	**Rice straw covered soil**
Nov. 12	28.5	29.6	26.5	27.0	11.2	14.2	18.8	15.8
Nov.27	23.4	25.5	23.0	23.5	9.7	12.8	16.0	14.0
Dec. 12	23.1	23.9	21.5	22.8	8.8	10.4	14.0	12.5
Dec. 27	17.5	19.9	18.0	20.4	9.2	11.6	15.4	13.4
Jan. 11	15.9	19.5	18.4	19.0	5.8	8.5	11.0	10.4
Jan. 26	18.0	19.6	18.5	19.0	9.4	11.1	15.4	13.4
Feb. 10	18.6	20.1	18.0	19.5	6.6	7.8	15.2	12.7
Feb. 25	24.0	24.9	23.9	24.0	9.5	11.1	15.8	13.5
March 11	27.4	30.4	29.8	29.8	11.8	14.1	18.0	15.9
March 26	32.5	35.8	35.5	34.0	15.7	19.0	22.4	19.7
April 10	36.8	41.3	41.0	39.8	17.5	21.7	25.0	22.4

ature differrence between mulched and unmulched soil were considerably less after plants developed a complete gro-und cover. The mulching effect of the black plastic resul-ted from the air layer between the soil surface and the plastic film. This air layer served as an insulator and thus reduced rate of heat transmission from the black plastic absorbing surface of the soil during the day and from soil to plastic film during the night. These results are in con- formity with the study made by Bennett et al. (1966), who observed that in cotton crop, the maximum soil tempe-ratures under black plastic mulch were as much as 25^{0}F lower than those of unmulched soil when plants were not large enough to shade the soil surface. Since rate of soil temperature change was considerably slower under the plastic film as compared to rice straw mulch, soil tempe- ratures were maintained in a more desirable range for plant growth especially in the month of December, Jan-uary and February under plastic mulch.

Mulch and weeds

In unmulched plots, the population of grass weeds, broad-leaved weeds and sedges constituted 28.2, 56.1 and 15.7% of total weed population (Table 2). Weed pop-ulation and dry matter accumulation by weeds significa-ntly influenced by planting method and mulch treatments, but different irrigation levels did not alter the weed popu-lation and weed dry matter significantly. Bed planting me-thod caused a significant reduction in weed population, which ultimately reduced the dry matter accumulation by weeds to the tune of 65.2% over ridge planting method. This may be due to more competition offered by the crop in bed planting method due to closer spacing as the crop sown in paired rows pattern, which helped in smothering the weed flora particularly at the initial stage of crop gro-wth. The weed population under rice straw and plastic mulch was found statistically same but significantly decr-eased over unmulched soil condition. However, plastic mulch resulted in significant reduction in dry matter accumulation of weeds by 37.4 and 63.8% over rice straw mulch and unmulched soil condition respectively. It was observed that most of the weed seed found light sensitive, so did not germinate under the plastic mulch so ultimately caused a reduction in population. The rice straw mulch provided good control over weeds at the initial stage, but in the later season of crop growth heavy weed infestation caused an increase in dry matter accumulation by weeds. It was interesting that nutgrass (*Cyperus rotundus*) penetrated the plastic but did not constitute a serious problem. The dry matter production of weeds in plastic mulched treatment was less due to increase in minimum temperature and vigorous growth of the baby corn plants as reflected in plant height which; caused an early canopy of crop and ultimately helped in smothering the weed flora.

Effect on plant growth

A perusal of table 2 indicates that plant height of baby corn significantly influenced by planting method and mulch treatments. Bed planting method registered grea-ter plant height (176.4 cm) than the ridge planting method (160.1 cm) . This may be due to greater competition offe-red by the crop in bed planting method against the we-eds. Plants were more vigorous in bed planting method as compared to ridge planting method. Further it had been observed that plants in plastic and rice straw mulch treatments attained more plant height as compared to unmulched soil condition. Plants in plastic mulch treatm-ent registered maximum plant height (188.9 cm). This may be due to excellent weed control, high water use effi-ciency in plastic mulch treatment along with early and vigorous growth of plants. It was also noticed that baby corn seedling emerged 2 and 4 days earlier in rice straw and plastic mulch treatment respectively. This was due to inc-reased minimum soil temperature (Table 2) and soil moisture content in the upper portion of the soil which pr-ovided an ideal environment for early germination and vigorous growth of the plant particularly at the initial stage of crop growth. The study also revealed that first picking of baby corn started two days earlier in bed planting met-hod as compared to ridge planting method. However, in plastic mulched treatment first picking started 11 days earlier than the unmulched treatment. This was due to the fast growth of plants in plastic mulched treatment as reflected in plant height. The days taken to babycorn har-vest were also influenced by irrigation schedules. At low-er levels of irrigations i.e. at 1.0 and at 0.8ETc, the first picking started two days earlier than the crop which was irrigated at 1.2 ETc. This may be due to mild water stress at 1.0 and at 0.8ETc, which caused a reduce- tion in transpiration and photosynthesis rate as a result, plants mature earlier in these treatments.

Yield and water use efficiency

Mean data of two years study (Table 3) revealed that baby corn and green fodder yield significantly influenced by planting method. Bed planting method resulted in 34.9 and 49.0% increase in baby corn and green fodder yield respectively over ridge planting method. This increase was due to more number of baby corns/plant, significant higher number of baby corns/plant and husked cob weight in bed planting method as compared to ridge plan-ting method (Table 2) . It was also observed that baby corn recovery (%) was more in bed planting method than ridge planting method. Black plastic mulch registered 18.9 and 77.5% increase in baby corn yield over rice-straw mulch and unmulched soil condition respectively. Similar trend was noticed in case of green fodder yield. Increase in baby corn yield was due to the higher number of baby corns/plant and higher baby corn recovery (%) in the mulched treatments. These results are in agreement

Table 2. Effect of different treatments on weed density, weed dry matter, plant growth and yield contributing characters of babycorn (Mean of two year)

Treatments	Weed density (No./m^2	Weed dry matter (q/ha)	Plant height (cm)	Days taken to first picking	Babycorns/ Plant (No.)	Babycorn weight (g)	Husked cob weight (g)	Babycorn length (cm)	Babycorn recovery (%)
Method of sowing									
Bed planting	176.0	3.60	176.4	136.1	2.15	4.78	23.4	5.67	20.4
Ridge planting	506.0	10.22	160.1	138.0	1.30	3.70	18.8	5.46	19.7
LSD (0.05)	100.0	2.21	14.5	0.3	0.28	0.48	2.5	NS	-
Effect of Mulch									
Plastic mulch	189.0	3.87	188.9	131.2	2.33	5.04	23.4	6.71	22.7
Rice straw mulch	296.0	6.18	167.9	137.0	1.94	4.79	22.5	6.38	21.2
Unmulched	539.0	10.7	148.8	142.9	0.89	2.90	17.5	3.60	16.5
LSD (0.05)	122.0	2.7	17.8	0.4	0.34	0.6	3.1	0.4	-
Irrigation schedules									
1.2 ETc	264.0	5.28	176.4	138.4	2.33	4.75	24.5	5.89	19.4
1.0 ETc	336.0	6.87	164.9	136.8	1.61	4.49	21.3	5.54	21.0
0.8 ETc	424.0	8.59	164.4	136.0	1.22	3.49	17.4	5.27	22.0
LSD (0.05)	102	2.12	NS	0.5	0.25	0.3	1.9	0.3	-

LSD : Least significant differences

Table 3. Effect of different treatments on baby corn yield, green fodder yield, water use and water use efficiency of the crop

	Babycorn yield (q/ha)			Green fodder yield (t/ha)			Irrigation water applied (cm)			Water use efficiency (kg/ha-cm)		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Method of sowing												
Bed planting	10.4	12.6	11.6	21.7	23.9	22.8	45.1	36.9	41.0	23.0	34.1	28.3
Ridge planting	7.6	9.5	8.6	14.0	16.5	15.3	45.1	36.9	41.0	16.8	25.7	21.0
LSD (0.05)	1.3	1.3	1.0	1.9	1.3	1.2	-	-	-	-	-	-
Effect of mulch												
Plastic mulch	11.1	14.2	12.6	21.0	23.3	22.1	45.1	36.9	41.0	24.6	38.4	30.7
Rice-straw mulch	9.8	11.1	10.6	18.8	21.2	20.0	45.1	36.9	41.0	21.8	30.0	25.8
Unmulched	6.1	8.0	7.1	13.8	16.1	15.0	45.1	36.9	41.0	13.6	21.7	17.3
LSD (0.05)	1.61	1.6	1.27	2.4	1.6	1.5	-	-	-	-	-	-
Irrigation schedules												
1.2 ETc	10.4	12.3	11.5	19.9	21.9	20.9	52.8	44.1	48.4	19.7	27.9	23.8
1.0 ETc	9.3	11.4	10.3	18.2	20.4	19.3	44.8	36.9	40.8	20.7	30.9	25.2
0.8 ETc	7.3	9.6	8.4	15.5	18.3	16.9	37.6	29.7	33.6	19.4	32.3	25.0
LSD (0.05)	0.7	0.8	0.5	1.3	1.6	1.1	-	-	-	-	-	-

LSD : Least significant differences

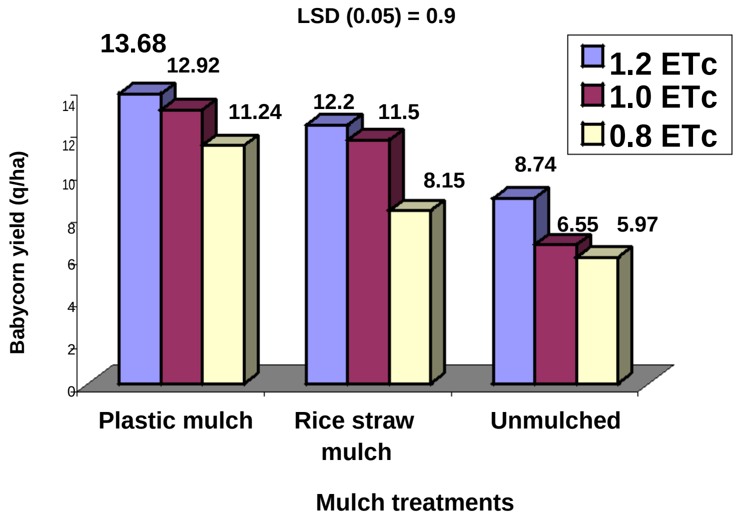

Figure 2. Showing interaction effect of mulch and irrigation schedules onbaby corn yield (Mean of two years)

with previous reports on the beneficial effect of black polyet-hylene mulch through its effective weed control, conser- vation of soil moisture and increasing soil temp-erature (Chhangani, 2000; Rahman and Khan, 2000; Vavrina and Roka, 2000; Gimenez et al., 2002). Similarly Kwabiah, (2003) observed that microclimate modification induced by plastic mulch improved dry matter, yield and quality of field corn. In the first year rice straw mulch pro-vided good control over weeds, so the baby corn and fodder yield in the first year was statistically same in both the plastic mulch and rice straw mulched treatments. But in the second year, higher weed infestation in the later part of the season appeared to be the main reason for reduction in baby corn and green fodder yield in rice straw mulched treatment over the plastic mulched treat-ment. Under irrigation schedules, it was seen that irriga-tion at 1.2 ETc resulted 11.6 and 36.9% increase in baby corn yield over 1.0 and 0.8 ETc respectively. This was due to higher number of baby corns/plant, baby-corn length and husked cob weight in irrigation level of 1.2 ETc as compared to 1.0 and 0.8 ETC respectively (Table 2). Green fodder yield in bed planting method, plastic mulch treatment and at irrigation level of 1.2 ETc was more (Table 3) due to greater plant height and more vegetative growth in these treatments as compared to rest of the treatments.

The study further revealed that water use efficiency was recorded maximum (Table 3) in plastic mulched trea-tment (30.7 kg /ha/cm), while it was minimum in unmulc-hed treatment (17.3 kg/ha/cm) . Water use efficiency was not much affected by irrigation levels. It was almost same at 0.8 and 1.0 ETc, however slightly decreased at 1.2 ETc. This may be due to that with increased water supply, the increased in evapotranspiration (ET) is propo-rtionally higher than the increase in yield up to certain limit. The lowest water use efficiency was recorded in un-mulched treatment, as formation of reproductive structure of sink was not enough to give a better yield due to more infestation of weeds.

Interaction effect of mulch treatments and irrigation levels was found significant (Figure 2). The mean data of two-year study revealed that baby corn yield at irrigation level of 1.2 and 1.0 ETc in both plastic and rice straw mulched treatment was statistically same, but significan-tly higher than irrigation level of 0.8 ETc, while in unmulc-hed soil condition, baby corn yield was statistically same at irrigation level of 1.0 and 0.8 ETc, but significantly lower than irrigation level of 1.2 ETc. Further, the study indicated that plastic mulch even with lower level of irrig-ation 0.8 ETc gave statistically same yield as obtained in rice straw mulch treatment, when it was irrigated at 1.0 ETc with maximum water use efficiency of 33.4 kg/ha-cm. It was interesting that plastic mulch at lower level of irrig-ation 0.8 ETc resulted 28.6% increase in yield over unm-ulched soil condition even when it was irrigated at higher level of irrigation 1.2 ETc and resulted 30.6% of water saving.

Interaction effect of planting method, mulch treatments and irrigation schedule was also found significant (Table 4) . A careful examination of data in table 4 revealed that in bed planting method, plastic mulch treatment proved superior than rice straw mulch treatment at all the levels of irrigation but the magnitude was higher at lower level if irrigation i.e. 0.8 ETc. This was due to better water use efficiency and weed control at lower level of irrigation i.e. 0.8 ETc in bed planting method due to the plastic mulch as compared to ridge planting method. The study also indicate that in bed planting method, plastic mulch resul-ted statistically same baby corn yield at all the levels of irrigation with maximum water use efficiency of 40.1 Kg/

Table 4. Interaction effect of planting method, mulch and irrigation schedules on babycorn yield (Mean of 2 years).

	Bed planting method			**Ridge planting method**		
Irrigation schedules→	1.2 ETc	1.0 ETc	0.8 ETc	1.2 ETc	1.0 ETc	0.8 ETc
Plastic mulch	14.59 (30.1)	14.32 (35.1)	13.74 (40.1)	12.77 (26.4)	11.52 (28.2)	8.73 (26.0)
Rice straw mulch	13.33 (27.5)	12.92 (31.7)	8.97 (26.7)	11.07 (22.9)	10.08 (24.7)	7.33 (21.8)
Unmulched	11.23 (23.2)	8.06 (19.7)	7.28 (21.7)	6.25 (12.9)	5.04 (12.3)	4.66 (13.9)
LSD (0.05)	1.3					

Figure in parentheses indicate water use efficiency (Kg/ha-cm); LSD: Least significant differences

kg/ha-cm at irrigation level of 0.8 ETc, while in ridge planting method the baby corn yield was statically same only at irrigation level of 1.2 and 1.0 ETc, while at 0.8 ETc it decreased significantly. This was due to better water use efficiency and control of weeds due to plastic mulch treatment in bed planting method as compared to ridge planting method.

Conclusion

It was concluded from the study that higher yield of baby corn can be obtained in bed planting method and further plastic mulching in bed planting method boosted the baby corn yield over unmulched soil condition and the magnitude was higher at lower level of irrigation 0.8 ETc with highest water use efficiency of 40.1 kg/ha-cm. Plastic mulch increased minimum temperature of soil, accelerated early growth and plant height, fruiting of plants and gave satisfactory weed control without any application of herbicides. Thus this system is not only expected to increase profits in certain rain fed and irrigation situations, but it is also expected to results in environmental and social benefit by reducing the load of herbicides on agro- eco system. So, in nutshell, plastic mulch may have an important application in boosting the supply of staple crops especially in water hunger areas or for those areas, which have some oil reserves from which plastic mulch can be produced as a byproduct.

REFERENCES

Bennett OL, Ashley DA, Doss BD (1966). Cotton response to black plastic mulch and irrigation. Agron. J. 58: 57-60.

Chhangani S (2000). Effect of mulches (synthetic and nonsynthetic) on water conservation and bulb yield of irrigated onion (*Allium cepa* L.) cultivated in semi-arid zone of Borno State, Nigeria. J. o*f* Ecophysiology. 3: 5-9.

Duranti A, Cuocolo L (1989). Chemical weed control and mulching in onion (*Allium cepa* L.) and garlic (*Allium sativum* L.). Advances in Horticultural Science. 37: 338-342.

Gimenez C, Otto RF, Castilla N (2002). Productivity of leaf and root vegetable crops under direct cover. *Scientia Hort.* 94: 1-11.

.Pandey AK, Prakash V, Gupta HS (2002). Effect of integrated weedmanagement practices on yield and economics of babycorn . Indian J. Agric. Sci. 72: 206-209.

Rahman MS, Khan, MAH (2001). Mulching – induced alteration of microclimatic parameters on the morpho-physiological attributes in onion (*Allium cepa* L.). Plant Prod. Sci*,* Bangladesh 4: 241-248

Shaw RH (1959). Water use from plastic covered and uncovered corn plots. Agron. J. 51: 172-173

Vavrina CS, Roka FM (2000). Comparison of plastic mulch and bare-ground production and economics for short-day onion in a semi-tropical environment. Horticultural. Technol. 10: 326-330.

.