Effect of Polyethylene on Fruit Yield and Morpho-Biochemical Features During Ripening of a Local Tomato Cultivar Grown in a Tropical Environmental Condition, India

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The work was assessed the field performance of Polythene cover on morphology, fruit yield and post maturation changes on growing tomato(*Lycopersicon esculentum*).Data revealed that use of polythene gave adverse effect on average height in treated condition but favorable for matured ripen fruits(41.5%). Significant correlation observed in the post maturation(0.731, *P*d"0.01) and fruits ripening time (0.605, *P*d"0.01) .The fruit yield was found to be significantly increased by 61.23% .Polythene induced ripening had shown the variation in the amount of lycopene (429.3mg/100gm), protein (1.92%), ascorbic acid (23.68 mg/ 100gm) and the sugar(5.02%). Polythene covering was significant and positively correlated with lycopene(0.788, P<0.01),lipid(0.853, P<0.01),ascorbic acid(0.515 P<0.01) but negatively correlated with protein(-0.221P<0.05).Maturity at harvest is a very important attribute to tomatoes quality that found to be regulated by the use of polythene. Analysis of variance also showed statistically significant result in the lipid (F-value=14.688801,pd"0.01) ,sugar(F value= 25.52718,pd"0.01) and ascorbic acid (F-value=9.44343,pd"0.01).

Keywords: Polyethylene, Post mature changes, Biochemiccal features, *Lycopersicon esculentum.*

The role of plants in maintaining human health is well documented. Fruits and vegetables possess protective effect against different degenerative diseases due to the presence of various phytochemicals, carotenoids, vitamins and minerals(Srivastava and Kulshreshtha,2013). The common garden tomatoes are botanically classified as a fruit but many people considered as a vegetable. The department of Agriculture,USA has defined tomato as a vegetable belongs to Solanaceous family(Opadotun *et al*., 2016). *L. esculentum* is one of the highly valuable and constitutes among the major vegetable crops around the world.It is a daily used food item due less sugar, low acidic PH ,good seasoning and delicious in taste(Beckles 2012).â-carotene, polyphenols and vitamin C of tomato are thought to be potent antioxidants that has been rich in phytochemicals(Tyssandier 2004).Many factors such as cultivation method, growth parameters, temperature, light, soil type, mineral nutrients and ripening conditions have been affecting ripening and harvesting timing and also the quality of vegetation.

Vegetable production increases manifolds in recent years but the per capita consumption of

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vegetables in India is only about210 gm /day/person which is far lower than the minimum dietary need of 300 gm/day/person(Singh and Chaubey, 2013). It is indispensable to adopt different methodologies to enhance the production .Even though the humid tropical weather favors cultivation of a wide range of vegetables, a number of constraints including shortage of water,land, labor etc. limit the cultivation. As per the plasticulture society ,there is extensive use of polythene ,plastic plate, coverings, seedbeds etc. to augment the yields (Lamont *et al*., 2000).These are widely used as popular model to study plant biology under stresses,microbial infections and diseases(Wang *et al*., 2010; Fischer *et al*., 2011; Page *et al*., 2010).

The present study has set up to investigate the possible correlation between polyethylene cover and the morphological-chemical changes, fruit yields , assess the maturity and ripening process in tropical area like Bhubaneswar.

MATERIALS AND METHODS

The experimental item *Lycopersicon esculentum* was chosen because of its easy cultivation, medium in size, short life span, easy to handle ,less cost , small space requirement and widely consumed items in the locality .The experiment was conducted in spring –summer of 2012-2013 in a tropical environmental conditions at Bhubaneswar , Khurda with average fall of rain 1449.1 mm and temperature varied between 19.7°C (winter) to 32.5°C(summer).Physico-Chemical properties revealed the soil as lateritic, slightly acidic pH (5.4)with less amount of phosphorous, calcium but medium amount of potassium and nitrogen.

The desired healthy seeds were procured from University of Agriculture,Odisha and treated with 10% fungicide. A 25feet square area was taken for seed bade. The soil was tilted loosen ,mix with manure (cow dung) and leveled. The four sides of the nursery were covered with net. After 2-3 days seeds were germinated and grew up a little seedling on 25-30 days.The good and healthy seedling had been selected and transplanted from nursery to main field,keeping distance of two feet among lines and plants . Black Polyethylene (30x15 length and 0.3 micron thickness) was washed and treated with5% fungicides. The young plants, flowers, small fruits and half ripen fruits were covered with these polyethylene.

Preparation of samples

Maturity was assessed by observing color as proposed by Nielsen(2003).The fresh tomatoes were cleaned and divided into two parts. One part was blended into paste for determination of moisture while other part was used for biochemical analysis.

Moisture content

Known weight of the sample(5g) was taken on a pre weighed aluminum dish (M_1).The dish containing sample(M_2) was placed in the oven at 100^{o}c for two hour , the dish was move to desiccators and allowed to cool. The dish containing a dried sample was weighed (M_3)(AOAC 1975).

Moisture(%)= [M2 - M3 / M2 – M1] x100

Lipid content

Lipid was extracted through SoxhletËs Apparatus (AOAC 2004).Test sample (four gm) was taken in a thimble that put in SoxhletËs extractor . Extraction process carried on for 4 hours. Thimble was kept in desiccator and weighed.

Protein content

Protein was estimated by Kjeldahl method (Imtiaz *et al.,* 2015) .Test sample was taken in to Kjeldahl flask and digested with H_2SO_4.The digested sample was made alkaline and titrated with Hydrogen Chloride solution. The protein content was obtained multiplying the nitrogen value (6.25).

Total Sugar content

Aliquot from the filtrate was taken and ten ml of hydrochloric acid added and the inversion was carried out. The contents neutralized with sodium hydroxide using phenolphthalein as indicator and titrated (Ranganna 1986).

Lycopene content (mg/100gm)

Tomato fruits were finely ground. One gm of the puree was centrifuged and supernatant collected. The absorbance of supernatant (hexane layer) containing lycopene was taken at the wavelength of 503 nm(Fish *et al.,* 2002).

Ascorbic acid content (mg/100gm)

It was determined as per Ranganna(1979) by taking homogenized sample and titrating with indophenol solution until a faint pink color develop.

Statistical analysis

The statistical analysis was performed with MSTAT-Statistical package and ANOVA was used to assess the level of significance (MSTAT 1988 ;Rajablariani *et al.,*2012).

RESULT AND DISCUSSION

Morphological features

During the course of experiment both normal and polyethylene covered treated plants, flowers and fruits were measured, analyzed and recorded (Table 1**).** Average height of young plant ranged from 18.5-23.4 cm in normal or control and 16.8-20.5cm in treated condition. The frequency of fallen young tomato flowers found to be varied 9% to 15.5 % in normal and 19.5% to 39.0%under polythene cover. The frequency of fallen young tomato fruits during experimental periods found to be varied 7.8% to 14.3 % in normal and 17.5% to 33.0% under polythene cover and the highest overall percent (34%) of fallen fruits were observed at 14 days of observation. The percent of fallen flowers, fruits and increased in size under polyethylene cover fruits were found to have a linear relationship with duration of treatment. Ashrafuzzaman *et al*., (2011) also expressed similar view in their experiment. Post mature changes in increase of fruit size (Figure 1) by 9.4% to 18.7% in normal and 28.2% to 41.5 % under polythene covered whereas fruit yield under polythene cover increased by 61.23%.Diametric analysis of tomato fruits found to have average transverse diameter 2.7cm and weight 65gram in normal and average transverse diameter 3.8cm and weight became 89.5 gram in treated condition. Duration of ripening fruit(Figure 2) also found to be reduced in treated condition by 55.4 percent.The initial ripening from day of maturation took 4days and full ripening in 6.5dayswhereas untreated condition took 5 to 10.5 days.Use of Polyethylene cover found to have significant correlation(Table 2)with fallen flowers(0.211, *P*d"0.05), post maturation time(0.731, *P*d"0.01), transverse diameter(0.539,

Table 1. Morphological features of Tomato plant

Observation In days		total plant for observation		Total no. of flowers for observation		% of fallen flowers	
Percent of fallen tomato flowers in control and treated							
normal	Polythene covered	normal	Polythene covered	normal	Polythene covered	normal	Polythene covered
7	7	20	20	100	100	9	19
14	14	20	20	100	100	15	39
Per cent of fallen young tomato fruits in control and treated							
Observation In days		Total plant for observation		Total fruits for observation		% of fallen fruits	
normal	Polythene covered	normal	Polythene covered	normal	Polythene covered	normal l	Polythene covered
7	7	20	20	100	100	7	17
14	14	20	20	100	100	14	33
Per cent of post mature changes of tomato fruits in control and treated							
Observation In days		Total plant for observation		Total fruits for observation		% of increase fruits size	
normal	Polythene covered	normal	Polythene covered	normal l	Polythene covered	normal	Polythene covered
7	7	20	20	100	100	10	28
14	14	20	20	100	100	18	41

*normal=Without polythene cover(control), Polythene covered=Experimental

*P*d"0.01) , fruits ripening time(0.605, *P*d"0.01)and fruit yield(0.571 , *P*d"0.01) of tomato plants.

The test result showed that Polyethylene had more adverse effect on young plants but favorable for matured and ripen condition**.** This may be due to the effects that light absorption and reflection from polyethylene cover had on the plant's phytochrome regulatory system. Experimental work of Orzolek et al.(2000) documented polythene impact on maturing conditions.Other possibilities of adverse effects are reduce supply of carbohydrate at early development, competitive inhibitors that may be indigenous or exogenous from other sources. The microclimatic conducive parameters may be developed by the polyethylene might have provided a suitable condition for producing higher growth and development. The rise of output related with favorable microclimate condition, light induce parameters, pathogen management. The similar role of respiratory substrate and inhibitors in the vegetation also analyzed by Ba-RG and Burg(1967).

Table 2. Correlation coefficients (r) between polythene and morphological features

Parameters	Correlation coefficient(r)	Significance
Polythene & fallen flowers	0.211	*
Polythene & fallen young fruits	0.103	*
Polythene & post mature changes of fruits	0.731	**
Polythene & transverse diameters	0.539	**
Polythene & fruits ripening time	0.605	**
Polythene & fruits yield	0.571	**

*, ** Significantly correlated at 0.05 and 0.01 respectively

Table 3. Biochemical features of Tomato

Parameters	Days			
	7		14	
Biochemical constituents	Control	Treated	Control	Treated
Moisture(%)	93.81±0.22	92.45±0.03	92.28±0.02	88.15±0.08
Total lipid(%)	0.81	0.92	0.88	1.17
Total protein(%)	2.57±0.02	2.36±0.05	2.20±0.02	1.92±0.02
Total sugar(%)	1.8	2.1[e]	3.17	5.02[d]
Lycopene(mg/100gm)	147.6	218.5	264.8	429.3
Ascorbic acid(mg/100gm)	12.5	17.4	18.5	23.68

Table 4. Correlation coefficients (r) between polythene and biochemical features

Parameters	Correlation coefficient®	Significance
Polythene & Moisture	-0.097	ns
Polythene & Total lipid	0.853	**
Polythene & Total protein	-0.221	*
Polythene & Total sugar	0.287	*
Polythene & Lycopene	0.788	**
Polythene & Ascorbic acid	0.515	**

*, ** Significantly correlated at 0.05 and 0.01 respectively

Biochemical features

The biochemical analysis(Table3), correlation coefficient(Table4) and anova(Table5) were performed and statistically analyzed. The major component of the fruit was moisture(Table 3)whose value was ranged from 88.15% to 93.81 %.The moisture content was found to be decreased with maturation and ripening process. The amount of moisture content corresponds with the values reported by study of Gupta *et al* .,(2006) and De Souza *et al.,* (2008). Negative correlation was observed between polythene & moisture (r= 0.097). Lipid content fluctuated from 0.81to 1.17 %. In the present investigation, the total lipid level showed a gradual increase with maturation process. The positive correlation was observed between polythene &lipid (r=.853at pd"0.01). Significant variations(Table5) also observed in the analysis of variance (F-value=14.688801,pd"0.01).

Protein content was found to be varied from 1.92 to 2.57%.The decreased values was obtained with maturation process. It has been observed a reduced protein amount with increase maturation that may be due to rise in the secretion of volatile substances.A significant negative correlation observed with polythene cover(r= -.221*at pd"0.05).The amount of sugar content ranged from 1.8 to 5.02% .The highest value

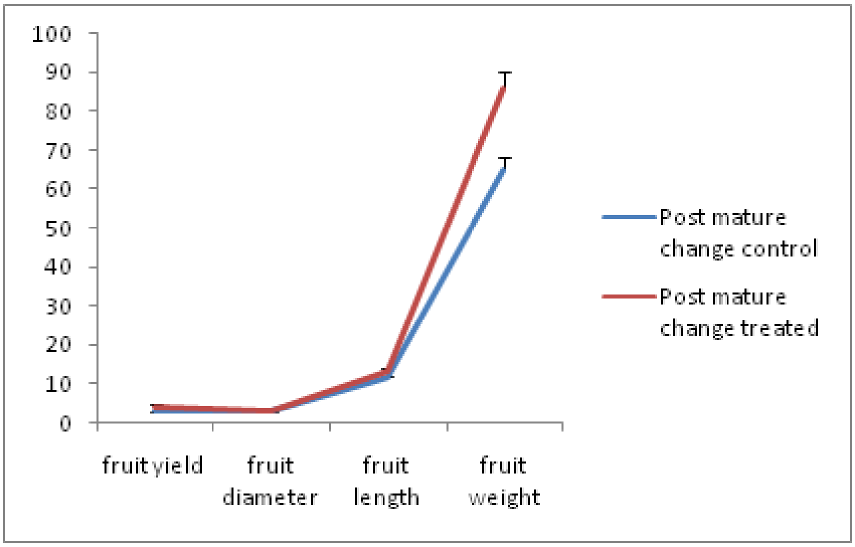

Fig. 1. Post mature change of fruit and fruit yield

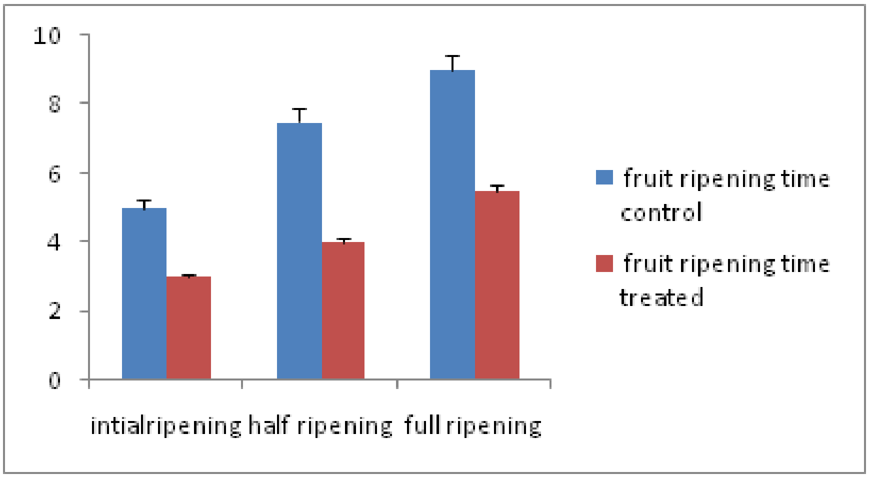

Fig. 2. Fruit ripening time

Table 5. Analysis of variance (ANOVA)on biochemical feature

Parameter	Unit	SS	MS	ANOVA F-Value	P-Value
Moisture	percent	368.521	74.091	1.371094NS	P≥0.05
Lipid	%	3.834	0.703	14.688801**	p≤0.01
Protein	%	217.3771	29.70643	0.897974 NS	P≥0.05
Sugar	%	6520.935	1508.93573	25.52718**	p≤0.01
Lycopene	mg /100mg	7.577352	1.64332	4.53815*	p≤0.05
Ascorbic acid	mg /100mg	31073.8	7010.9153	9.443143**	p≤0.01

was 5.02% in 14 day of treatment with positive correlation (0.287, *P*d"0.01).ANOVA analysis showed significant variations (F value= 25.52718, pd"0.01).The results also agreed with Petro-Turza(1987)but result of another work found to be noted from 3.44 to 0.54 percent that may be due to a different cultivar Melkamu *et al.,*(2008).

Lycopene content fluctuated from 147.6 (mg/100gm) to 429.3 (mg/100gm). The systems of cultivation seem to have significant influence on the lycopene due to high correlation coefficient(0.788 at pd"0.01) and variance value(F-value=4.53815, pd"0.05).The full maturation and redness of Lycopersicon due to increase synthesis of lycopene pigment.The work of Radzevièius *et al*.,(2009)also confirmed that the pigmentation directly related with ripening and maturation process.Gonzalez-Cebrino *et al*.,(2012) reported that lycopene contents changed widely among all investigated cultivars during ripening, increasing significantly from6.57 mg kg-1 (III ripeness stage) to 132.64 mg kg-1 (VI ripeness stage).The ascorbic acid varied from 12.5(mg/100gm) to23.68 (mg/100gm). This value indicate that ripening has a considerable correlation (r=.515**at pd"0.01) as well as in the variance analysis (F-value= 9.443143, pd"0.01). Such type of observation has been reported by investigator Oliveira *et al.*,(2013).

Response of polyethylene cover can be assessed in two developing stages. The initial phase lead to a developmental pause and abscission but the later stage correspond with enhances growth and maturation which was marked with fast tissue growth and increase ribosomal as well as enzymatic activities. Polyethylene induced maturity and ripening may causes more glycogenolytic metabolic activities. Reduced growth in initial phase due to wanting of respiratory substrate. Polyethylene may also affect indigenous secretion of ethylene ,rise of temperature and induced visible light spectrum promoting reduction of time and causes early maturation without affecting texture and quality.

CONCLUSION

The ripening and biochemical composition of fresh tomato depend on cultivars ,maturity, light, season, temperature, climate, irrigation, soil fertility, cultural practice etc. besides these factor, impact of polythene has been well marked. This study has commercial importance as ripening and harvesting at proper time always give benefit to the farmer and consumers.

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