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Research Article

Response of Hot Pepper *(Capsicum annum L.)* Varieties to Organic Mulching Materials at Guto Gida, East Wollega, Ethiopia

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Abstract

The study was carried out in 2021/22 under irrigation with the objectives of investigating the response of hot pepper (Capsicum annum L.) varieties to organic mulching materials. The treatment consisted of three pepper varieties (Oda haro, Bako local and Mareko fana) and five levels of organic mulching materials (Control, Maize straw, Soybean straw, Sesame straw, and Cattle manure) and combined factorially and laid out in Randomized Complete Block Design with three replications. The results of analysis of variance indicated that the effects of varieties and organic mulching materials were significant ($P<0.05$) for all parameters. All agronomic traits except days to 50% flowering, number of seeds per fruit and fruit dry weight were significantly affected by the combined effect of organic mulching materials and hot pepper varieties. Mareko fana variety with Cattle manure resulted the highest Marketable yield (1561.1kg/ha). In general, application of cattle manure for pepper varieties, especially Marekofana improved vegetative growth and marketable yield. Thus, hot pepper growers in the study area can use Cattle manure as mulching material that would improve productivity of the crop. However, to give more conclusive recommendation, this experiment should be repeated over locations and cropping seasons by increasing the number of hot pepper varieties.

Keywords

Organic Mulching Materials, Hot Pepper, Varieties, Marketable Yield, Unmarketable Yield

1. Introduction

The hot pepper *(Capsicum annum L.)* is commonly grown in Latin America and is a member of the Solanceae family [1]. In Ethiopia, it has a great economic importance both for small holder farmers and export earnings [2]. It is a high value crop used as vegetable and spice crops around the world for its pungent flavor and aroma [3]. Because it is wide accepted in the Ethiopian diet, it is an essential traditional crop mainly used for its pungency and color [4]. Hot pepper is the second most important vegetable in the world next to tomato [5]. It is a great source of vitamins and minerals, including vitamins A, E, and C, which are essential for human health [6]. Peppers are very important in fresh and processed forms along with different spices for daily consumption [7].

In Ethiopia, the total area under hot pepper production for dry

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pod has enhanced to 174,463.62 hectares with the total production of about 3,131,154.28 quintals [8]. The total production of red pepper in the country for the year 2019/20 increased in 1.35% than the production year of 2018/19. Vegetables took up about 1.64% of the area under all crops at national level. However, of the total estimated area under vegetables, the lion share which is about 73.13% and 17.81% was under Red peppers and Ethiopian Cabbage, respectively. In spite of its importance, hot pepper production in Ethiopia is stayed as low with a national average yield of 5.9 t/ha for green pod whereas it was 1.8 t/ha for the dry pod [8].

Mulching is a process of covering the soil providing better medium for plant growth and development. It is an important cultural method that helps to produce healthy plants with good productivity [9]. Mulching has been found to reduce losses of water through evaporation from soil. In addition, it reduces weed problem, maintaining a thermal regime in the root zone. Organic mulches improve the condition of soil by providing organic matter through decomposition which causes loosening of soil and improves root growth [10]. The moisture retained by mulching materials will be used for plants for many weeks or even months.

The main constraints that contributed for lower productivity in Ethiopia are type of cultivar, traditional and backward production methods, pest and disease, lack of proper and adequate inputs (fertilizers, improved seeds, pesticides, etc,), lack of research outputs and lack of extension services on production techniques, and many other problems [11]. Using organic mulches like crop straws protect vegetables from direct contact with soil in addition to conserving soil moisture and improving quality of soil, thereby improve crop productivity. Crop straw and cattle manure are easily available, low cost and soil friendly. However, information specifically focusing on the effect and type of organic mulching materials and using improved hot pepper varieties is lacking in the study area.

1.1. General Objective

To improve the production of hot pepper by organic mulching thereby improves the livelihood of the producers.

1.2. Specific Objectives

1. To determine the effect of organic mulching materials on yield of hot pepper varieties.
2. To evaluate the yield performance of hot pepper varieties.

2. Material and Methods

2.1. The Study Area

The study was conducted under irrigation at Guto Gida district, East Wollega zone, Western Ethiopia. Guto Gida district is located at the 8011’52 and 10094’44 North latitude and 360 97’51 and 37° 11’ 52 East longitude, and the altitude of 1300-1500 masl above sea level, with a prevalence of lowlands. The district is characterized a gentle slope, the soil texture of this area is loamy soil (42.8%), sandy soil (23.09%), clay loamy (16.33) and clay soil (8.08) slow land climate and partially acidic soil. Maximum and minimum average annual temperatures were 31-16 C^0 respectively. The farming system of the local society was mixed farming system that involves animal husbandry and crop production (Guto Gida Agricultural Office, 2009, Unpublisded data).

2.2. Treatments and Experimental Design

Table 1. *Description of hot pepper varieties.*

Variety	Year of release	Maintainer	Adaptation m.a.s.l	Temperature (°C)	Rain fall	Seed source
Mareko Fana	1976	MARC	1400-2200	20/29	600-1337	BARC
Bako Local	1976	BARC	1400-2120	20/29	600-1237	BARC
Oda Haro	2005	BARC	1400-2200	13.3/27.9	830-1559	BARC

Source: MoARD, 2009. BARC (Bako Agricultural Research Center), MARC (Melkasa Agricultural Research Center).

Three varieties of pepper, *Bako local, Marekofana* and *Oda haro* and four types of mulching materials, Maize straw, Soybean straw, Sesame straw and Cattle manure, were used as experimental treatments and the experimental design was be Randomized Complete Block Design with three replications. The total number of treatments was 3 pepper varieties x 4 mulch types and control (no mulch), 15 (3 x 5) treatments. The experimental plot was 3*4m ($12m^2$). The spacing used was 60cm b/n rows and 25cm b/n plants.

2.3. Experimental Procedures

The experimental field was prepared by using local plough, maresha. The experiment was conducted under irrigation. Seeds of pepper varieties were sown on seed bed and irrigated using spraying cane. Transplanting was done at the stage when

the sprouts have reached 20 to 25 cm in height or at 45 days after sowing on well prepared plots at a spacing 60cm b/n rows and 25cm b/n plants. Cattle manure was applied one week before transplantation, while crop straw mulches were applied immediately after transplantation. Other agronomic practices were applied according to the recommendation for the crop.

2.4. Data Collection

Days to 50% flowering (DF): When approximately 50% of the plants in a plot forms some flowers that are in bloom.

Days to fruit maturity (DM): When approximately 70% of the plants in a plot have fruits that attained physiological maturity.

Plant height (PH, cm): At blooming stage, the heights of 6 randomly plants per plot were measured.

Fruit length (FL, cm): The mean fruit length for 6 randomly selected plants in the plot and it was measured on three fruits (lower, middle and upper positions).

Number of primary branches (NPB): The number of primary branches of 6 randomly taken Sample plants per plot was recorded.

Number of fruits per plant (NFPP): The total numbers of physiologically mature fruits per plant were counted over the harvest Period on randomly selected plant samples per plot.

Seed number per fruit (SNPF): The mean amount of seeds per fruit for 6 randomly taken plants at maturity.

Fruit dry weight (FDW, g): This was calculated from fruits of successive harvests from 6 random sample plants.

Thousand seed weight (TSW, g): The weight of 1000 seeds per plot was taken.

Marketable yield (MY, kg/ha): Total weight of fruits free from crack, damage by insect and diseases, etc.

Unmarketable yield (UMY, kg/ha): Fruits which are cracked, damaged by insect, diseases, birds and sunburn, etc.

Total Yield (TY, kg/ha): Mean weights of marketable and unmarketable fruits were then calculated to record total yield.

2.5. Data Analysis

The data collected was subjected to analysis of variance by the GLM algorithm of SAS version 9.2 software [12] (SAS, 2009). LSD (Least Significant Difference) was used for mean separation at 5% probability level.

3. Results and Discussion

3.1. Analysis of Variance

Table 2. *Analysis of Variance (ANOVA).*

Traits	Rep (df=2)	V (df=2)	MM (df=4)	V x MM (df=8)	Error (df=28)	Mean	CV (%)
DF	0.87 ^{ns}	510.47**	62.94**	0.58 ^{ns}	0.67	55.66	1.48
DM	25.36**	182.97**	373.11**	9.97**	0.25	126.8	0.39
PH	9.79 ^{ns}	217.2**	405.27**	9.17*	6.72	52.36	4.95
FL	4.32**	5.98**	50.68**	0.31**	0.03	7.76	2.32
NPB	5.34**	4.76**	64.41**	0.072*	0.03	7.35	2.39
NFPP	26.93**	48.83**	472.04**	3.81**	0.19	19.66	2.24
NSPF	242.83**	469.84**	1457.25**	3.4^{ns}	2.4	107.06	1.45
FDW	3.8**	3.69**	58.27**	0.08 ^{ns}	0.04	6.15	3.16
TSW	2.4**	1.32**	40.3**	0.095**	0.01	8.04	1.27
MY	20102.86**	10076.48**	581200.89**	169.8*	129.67	1236.19	0.92
UMY	711.42**	38.03**	5925.93**	127.93**	5.62	175.84	1.35
TY	28778.21**	10320.22**	666851.38**	358.89*	132.9	1412.03	0.81

**=significant at 1%,*=significant at 5% level of probability, ns=non-significant, DF= Days to 50% flowering, DM= Days to 70% maturity, PH=Plant height (cm), FL= Fruit length (cm), NPB=Number of primary branches per plant, NFPP= Number of fruits per plant, NSPF=Number of seeds per fruit, FDW= Fruit dry weight, TSW= Thousand seeds weight (g), MY= Marketable yield, UMY= unmarketable yield, TY= Total yield (kg/ha).

The mean squares obtained in analysis of variance were used to separate variety effects, organic mulching materials and their interactions. The mean squares from the analysis of variance showed statistically significant ($P \leq 0.05$) difference among the tested varieties and the organic mulching materials for all traits. The combined effect of mulching materials and varieties showed significant ($P \leq 0.05$) for all agronomic traits except days to 50% emergency, number of seeds per fruit and fruit dry weight. The presence of significant differences among the tested varieties might be due to the existence difference in genetic potential among varieties.

3.2. The Effect of Organic Mulching Materials on Phenology of Hot Pepper Varieties

Days to flowering

The combined effect of variety with mulching materials did not display significance difference on 50% days to flowering of pepper. However, the main effects, varieties and mulching materials indicated significance difference at ($P < 0.05$). The longest days to reach 50% flowering (61.53) was recorded from *Oda haro* variety and the minimum day (49.87) was recorded from *Mareko fana* variety (Table 3). [13] Concluded that there were significant differences among genotypes of chili pepper for earliness (days to 50% flowering and fruit maturity). Whereas, Cattle manure mulching material resulted the maximum days to 50% flowering (58.6) followed by Maize straw and Soybean straw. And the minimum number of days to 50% flowering was recorded from the control, unmulched plots (51.78) (Table 3). Days to 50% flowering was significantly accelerated by cattle manure, which was significantly rapid than the other mulching materials. This is a profound phenomenon exhibited for a longer indeterminant reproductive growth which ultimately aids to the overall fresh pepper yield. Research conducted by [14] confirmed that the use of straw mulch induced flowering and fruit number in pepper compared to other organic and plastic mulches.

Table 3. *Effect of varieties on days to 50% flowering of pepper.*

Varieties	Days to 50% flowering (DF)
Oda haro	61.53[a]
Bako local	55.6[b]
Mareko fana	49.87[c]
LSD (0.05)	0.62
Mulching materials	
UM	51.78[e]
SE	54.55[d]
SY	56.11[c]
M	57.2[b]
CM	58.6[a]
LSD (0.05)	0.79
CV%	1.48

*Parameters on same column with same symbol indicate that their means were not significantly different at $P<0.05$. Un mulched (UM), Sesame straw (SE), Soybean straw (SY), Maize straw (M) and Cattle manure (CM).

Days to 70% maturity

The longest time to 70% maturity was 140.7 days for *Oda haro* variety with cattle manure. And they are statically different with each other. The fewest number of days to maturity (116.5 days) was obtained from *Mareko fana* with control and it was statistically in par with the treatment *Bako local* x control (118.4 days). In general, longer days to reach maturity were recorded from mulching with Cattle manure, while shorter days to reach maturity were taken from the control. This might be because of vigorous and enhanced vegetative growth of plants at the expense of reproductive growth which brought about a delay in maturity. In contrast to this, [15] and [16] reported that organic mulches enhanced early flowering in vegetables.

Plant height (cm)

Bako local mulched with Cattle manure gave the tallest plant (65.39 cm) and statistically similar with *Bako local* x Maize straw with mean value of 61.99 cm. While the minimum plant height (37.57 cm) was gained from *Oda haro* variety with control and it was not significantly different from *Mareko fana* under control, 40.77 cm. Cattle manure resulted in the highest mean plant heights. This in turn could enhance the plant's ability to produce more assimilates which were reflected in the high dry weight. Generally, this plant height increment could be due to mulching conserved optimum soil moisture, maintained uniform soil temperature and suppressed weeds growth and also modified the soil properties. Higher plant height of capsicum under Lantana leaves and grass mulches compared to control treatments reported by [17]. According to [18], observed Lettuce plant height was significantly increased by mulching more than control.

Table 4. *Effect of organic mulching materials and varieties on days to maturity and plant height of pepper.*

	Days to 70% maturity					Plant height (PH, cm)				
	Mulching materials					Mulching materials				
	UM	SE	SY	M	CM	UM	SE	SY	M	CM
Oda haro	120.2^{kj}	124.9^{g}	130.9^{d}	136.8^{b}	140.7^{a}	37.57^{g}	48.65^{ef}	51.33^{ed}	52.26^{cde}	54.6^{cd}
Bako local	118.4^{kl}	122.9^{hi}	125.3^{g}	128.5^{e}	133.3^{c}	45.36^{f}	54^{cd}	56.37^{c}	61.99^{ab}	65.39^{a}
Marekofana	116.5^{l}	121.41^{ij}	124.6^{gh}	127.5^{ef}	130.1^{d}	40.77^{g}	53.16^{cd}	54.43^{cd}	54.22^{cd}	56.37^{c}
Mean	126.8					52.36				
LSD (0.05)	1.83					4.33				
CV (%)	0.39					4.95				

*Parameters in rows and column with same symbol indicate that their means were not significantly different at P<0.05. Unmulched (UM), Sesame straw (SE), Soybean straw (SY), Maize straw (M) and Cattle manure (CM).

Fruit length

The elongated fruit 11.43cm was recorded from interaction effect of *Mareko fana* and cattle manure. But it was not statistically different from *Bako local* x Cattle manure with mean value, 10.56cm. The shortest fruit, 5.22cm was recorded from *Bako local* variety under control and it was not significantly different from *Oda haro* and *Mareko fana* varieties under control with mean values 5.33 and 5.5cm respectively. These results are in conformity with the findings of [19], where significant increases in fruit length were observed in straw mulch compared to no mulching on cucumber. The increase in fruit length may be due to the varying moisture regimes in the soil for the different mulching materials used. [20] reported that the increase in the number of leaves would increase photosynthetic surfaces and the current photosynthates produced would enhance the physiological activities leading to production of more assimilates used to significantly increase fruit production, fruit sizes and fruit diameter. Larger and wider hot pepper pods are considered to be the best in quality and are more in demand for fresh as well as dry pod use in markets [2].

Number of primary branches

Table 5 showed mean values of varieties under organic mulching materials on primary branches of pepper. *Mareko fana* variety mulched with cattle manure respond peak primary branches (11.3). While the least primary branches (3.12) was recorded from *Oda haro* variety under control and, it was not significantly different from *Bako local* variety under control with mean value 3.63. All the mulches had the positive effect on generating and retaining a higher number of branches per plant. The positive effects of mulching could probably be associated with the reduction in nutrient loss due to leaching, reduction of soil heat, suppression of weed and conservation of moisture by the mulch materials [21]. Higher number of primary branches under straw mulch relative to the control plot on bottle gourd was recorded by [22].

Table 5. *Effect of organic mulching materials and varieties on fruit length and number of primary branches of pepper.*

	Fruit length (FL, cm)					Number of primary branches (NPB)				
	Mulching materials					Mulching materials				
	UM	SE	SY	M	CM	UM	SE	SY	M	CM
Oda haro	5.33^{kl}	6.3^{ij}	7.2^{gh}	8.4^{e}	9.73^{bcd}	3.12^{l}	5.4^{j}	6.87^{h}	8.53^{ef}	9.97^{bc}
Bako local	5.2^{kl}	6.5^{hi}	7.93^{efg}	9de	10.56^{ab}	3.63^{kl}	6.13^{ij}	7.7^{fgh}	8.97^{de}	10.3^{b}
Marekofana	5.5^{jl}	7.4^{g}	8.87^{de}	9.97^{bc}	11.43^{a}	4.1^{k}	6.53^{i}	8^{fg}	9.3^{cd}	11.3^{a}
Mean	7.76					7.35				
LSD (0.05)	0.87					0.92				

	Fruit length (FL, cm)					Number of primary branches (NPB)				
	Mulching materials					Mulching materials				
	UM	SE	SY	M	CM	UM	SE	SY	M	CM
CV (%)	2.32					2.39				

*Parameters in rows and column with same symbol indicate that their means were not significantly different at P<0.05. Un mulched (UM), Sesame straw (SE), Soybean straw (SY), Maize straw (M) and Cattle manure (CM).

3.3. Effect of Organic Mulching Materials on Yield and Yield Components of Hot Pepper Varieties

Number of fruits per plant

Mean values for the effect of variety with mulching materials on number of fruits per plant are presented in Table 6. The maximum number of fruits per plant (31.4) was recorded from interaction effect of *Mareko fana* and cattle manure and it was statistically different from *the rest treatments.* The minimum number of fruits per plant, (8.93) was recorded from *Oda haro* variety under control. The increase in the number of fruits per plant of mulched plot was probably associated with the conservation of moisture and improved microclimate both beneath and above the soil surface. The suitable condition enhanced the plant growth and development and produced increased fruit bearing nodes compared to the control. [23] Observed the increase in biological activities in the soil to influence nutrient availability and subsequently the fertility of such soils. The number of chilli fruits per plant differed significantly with glyricidia mulch and with crop residue mulch compared to no mulch [21]. Mulch material used influenced the number of chilli fruits per plant.

Thousand seed weight

Table 6 showed *Mareko fana* mulched with cattle manure provided the highest weight of thousand seeds (10.9g). While the minimum thousand seeds weight (4.7) was recorded from *Oda haro* variety under control and, it was not significantly different from *Bako local* variety under control with mean value 4.9g. Cattle manure resulted in the highest mean thousand seeds weight while; the minimum thousand seeds weight were produced under control for the three varieties. [6] indicated that, in some cultivars of Chili seed can contain up to 60% of the dry weight of the fruit which makes it an important economic part of the crop.

Table 6. *Interaction effect of variety by organic mulching materials on number of fruits per plant and thousand seed weight of pepper.*

	Number of fruit per plant (NFPP)					Thousand seed weight (TSW, g)				
	Mulching materials					Mulching materials				
	UM	SE	SY	M	CM	UM	SE	SY	M	CM
Oda haro	8.93^{l}	15.36^{j}	18.5^{h}	21.3^{f}	25.3^{d}	4.7^{j}	6.9^{h}	8.2^{f}	9.2^{d}	9.7^{bc}
Bako local	9.5^{kl}	16^{ij}	19.9^{g}	24.36^{de}	28.2^{b}	4.9^{ij}	7^{gh}	8.4^{ef}	9.4^{cd}	10.1^{b}
Marekofana	10.5^{k}	16.8^{i}	21.6^{f}	27.16^{bc}	31.4^{a}	5.2^{i}	7.4^{g}	8.7^{e}	9.77^{bc}	10.9^{a}
Mean	19.66					8.04				
LSD (0.05)	1.14					0.47				
CV (%)	2.24					1.27				

*Parameters in rows and column with same symbol indicate that their means were not significantly different at P<0.05. Un mulched (UM), Sesame straw (SE), Soybean straw (SY), Maize straw (M) and Cattle manure (CM).

Number of seeds per fruit

ANOVA showed a significant effect of varieties and mulching materials on number of seeds per fruit of hot pepper but, their interaction was non-significant (Table 2). The maximum number of seeds per fruit (112.4) was recorded for the variety *Oda haro* and the minimum (101.3) was recorded for variety *Bako local*. *Mareko fana* variety gave 107.5 seeds per fruit (Table 7). On the other hand, Plants treated under cattle manure produced the maximum number of seeds per fruit (120). The fewest seeds per fruit (87.1) were recorded from the control, un mulched plots (Table 7). The highest number of fruits and seeds under plots covered with mulch might be due to the favorable soil micro-climate conditions created by organic mulch application which increased the growth of hot pepper this in turn increased the number of seeds per pod and fruits per plant. These finding are in line with those obtained by [24] who found that number of fruits per plant was highest under Tithonia diversifolia leaf mulch than bare plot on tomato experiment.

Fruit dry weight

As indicated in the ANOVA Table 2, there was a significant effect of varieties and mulching materials on fruit dry weight of pepper. However, their interaction did not show a significant effect. Results indicated that the maximum mean fruit dry weight (7.1g) was recorded from variety *Mareko fana* but it was statistically in par with *Bako local* variety with a value (6.7g). While, the minimum value (6.4g) was obtained from *Oda haro*, but not significantly different from *Bako local* value. (Table 7). This might be due to the inherent genetic difference between the three varieties of the pepper. According to [25] individual yield components of chili pepper such as fruit length, width, and weight were influenced more strongly by pepper genotype. On the other hand, Plants treated with cattle manure gave the maximum fruit dry weight (8.28g) and, they were not significantly different from those plants under maize straw mulching material (7.8g). The minimum fruit dry weight (6.2g) was produced under control (un-mulched plots) (Table 7). [26] Observed increased fruit weight of hot pepper with straw mulching compared to the control. Previous research indicated that increased soil organic matter increased fruit number and fruit weight of chili pepper [27].

Table 7. *Effect of varieties on number of seeds per fruit and fruit dry weight of pepper.*

Varieties	Number of seeds per fruit (NSPF)	Fruit dry weight (FDW, g)
Oda haro	112.4^{a}	6.4^{b}
Bako local	101.3^{c}	6.7^{ab}
Mareko fana	107.5^{b}	7.1^{a}
LSD (0.05)	1.16	0.45
Mulching materials		
UM	87.1^{e}	6.2^{e}
SE	104.2^{d}	6.8^{cd}
SY	108.6^{c}	7.2^{c}
M	115.3^{b}	7.8^{ab}
CM	120^{a}	8.28^{a}
LSD (0.05)	1.49	0.49
CV%	1.45	3.16

*Parameters column with same symbol indicate that their means were not significantly different at P<0.05Un mulched (UM), Sesame straw (SE), Soybean straw (SY), Maize straw (M) and Cattle manure (CM).

Marketable yield (MY)

As indicated in the ANOVA Table 2, there was a significant effect of varieties and mulching materials on marketable yield of pepper. Results in Table 8 indicated that *Mareko fana* variety mulched with cattle manure provided the highest marketable yield (1561.1kg) and it was statistically different from other treatments. While the minimum value of marketable yield (839.4kg) was obtained from *Oda haro* variety under control. Cattle manure resulted in the highest mean marketable yield while; the minimum values were produced under control for the three varieties. Mulching with various varieties increased marketable dry fruit yield of hot pepper through modification of the crop growing environment by reducing weed infestation, soil depletion and ameliorating soil temperatures and also addition of nutrient to the soil through decomposition of organic mulching materials under investigation.

According to [28], the magnitude of genetic variability and heritability are necessary in systematic improvement of hot pepper for fruit yield and related traits.

Unmarketable yield (UMY)

ANOVA Table 2 showed significant effect of varieties, mulching materials and their interaction on unmarketable yield of pepper. Table 8 shows mean values of combined effect of organic mulching materials and pepper varieties on unmarketable yield. *Bako local* mulched with cattle manure resulted the highest unmarketable yield (202.2 kg/ha) and it was statistically different from all treatments. While the minimum unmarketable yield (126 kg/ha) was recorded from *Oda haro* variety under control and, it was significantly different from all treatments. Cattle manure resulted in the highest mean unmarketable yield while; the minimum unmarketable yield were produced under control for the three varieties. Therefore, the reason for higher unmarketable dry fruit under mulched plot was probably due to lower total dry fruit yield under the control.

Table 8. *Interaction effect of variety by organic mulching materials on marketable yield and unmarketable yield of pepper.*

	Marketable yield (MY, kg/ha)					**Unmarketable yield (MY, kg/ha)**				
	Mulching materials					**Mulching materials**				
	UM	**SE**	**SY**	**M**	**CM**	**UM**	**SE**	**SY**	**M**	**CM**
Oda haro	839.4^{m}	1109.1^{j}	1243.5^{g}	1374.8^{e}	1489.4^{c}	126^{j}	181.3^{fg}	196.7^{b}	175.78^{h}	193.2^{bc}
Bako local	860.2^{l}	1139.8^{i}	1265.5^{f}	1393.4^{e}	1512.9^{b}	133^{i}	177.16^{h}	190.5^{cd}	185.3^{e}	202.2^{a}
Marekofana	883.8^{k}	1164.4^{h}	1281.1^{f}	1424.5^{d}	1561.1^{a}	134.2^{i}	179.6^{hg}	184.1^{ef}	191.5^{c}	187.1^{de}
Mean	1236.19					175.84				
LSD (0.05)	19.04					3.96				
CV (%)	0.92					1.35				

*Parameters in rows and column with same symbol indicate that their means were not significantly different at P<0.05. Un mulched (UM), Sesame straw (S E), Soybean straw (SY), Maize straw (M) and Cattle manure (CM).

Total yield (TY) (kg/ha)

As the results in Table 9 shows, *Mareko fana* mulched with cattle manure resulted the highest total yield, (1740.7kg/ha). While the minimum total yields 965.4, 993.17 and 1018.1 kg/ha were produced by *Oda haro, Bako local* and *Mareko fana* varieties under control respectively. The increase in total dry fruit yield per hectare could be due to positive effect of hot pepper varieties with various mulching material, which modified the soil environment by conservation of soil moisture, maintenance of uniform soil temperature, suppression weed growth and addition of nutrient to the soil due to decomposition of the organic mulch material under investigation better than the control which leads to vegetative and reproductive growth of hot pepper variety, these in turn increased yield ultimately. Our findings on the other hand supports the work of [29] where they indicated that straw mulch enhanced plant height and increased fruit number and fruit yield in both pepper and tomato. According to [30] reported, the maximum fruit yield of bell pepper was obtained by applying organic mulch.

Table 9. *Effect of organic mulching materials and varieties on total pepper yield.*

	Total yield (TY, kg/ha)				
	Mulching materials				
	UM	**SE**	**SY**	**M**	**CM**
Oda haro	965.4^{l}	1302.3^{i}	1440.1^{g}	1550.56^{e}	1670.63^{b}
Bako local	993.17^{k}	1342^{h}	1456^{fg}	1578.76^{d}	1689.96^{b}

	Total yield (TY, kg/ha)				
	Mulching materials				
	UM	SE	SY	M	CM
Marekofana	1018.1[j]	1351.5[h]	1465.2[f]	1615.9[c]	1740.7[a]
Mean	1412.03				
LSD (0.05)	19.38				
CV (%)	0.81				

*Parameters in rows and column with same symbol indicate that their means were not significantly different at P<0.05. Un mulched (UM), Sesame straw (SE), Soybean straw (SY), Maize straw (M) and Cattle manure (CM).

4. Summary and Conclusion

As indicated in the ANOVA Table 2, all parameters except days to 50% flowering, number of seeds per fruit and fruit dry weight were statistically significant at 5%. Growth of hot pepper was significantly affected by various organic mulching materials. Among these mulching materials, cattle manure had given the maximum days to reach 50% flowering, number of seeds per pod and fruit dry weight. The highest and lowest values of number of primary branches per plant (11.3 and 3.12), number of fruits per plant (31.4 and 8.93), thousand seed weight (10.9 and 4.7 g), marketable yield (1561.1 and 839.4 kg/ha), total yield (1740.7 and 965.4kg/ha) were recorded for Marekofana treated with cattle manure and Oda haro with control respectively. As the experiment during 2021/22 shows, hot pepper growers in the study area can use Cattle manure as mulching material that would improve productivity of the crop. But, to put more conclusive recommendation, this experiment should be repeated over locations and cropping seasons by adding additional hot pepper varieties.

Abbreviations

ANOVA	Analysis of Variance
CSA	Central Statistical Authority
CV	Coefficient of Variation
GLM	General Liner Model
LSD	Least Significant Difference
RCBD	Randomized Complete Block Design
SAS	Statistical Analysis System

Author Contributions

Kelemua Zebene: Conceptualization, Methodology, Data curation, Investigation, Formal analysis, Writing – original draft, Writing – review & editing

Temesgen Fesika: Resources, Data curation, Methodology, Investigation.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Rodriguez, Y., Depestre, T., Gomez, O. (2008): Efficiency of selection in pepper lines (Capsicum annuum) from four subpopulations in characters of productive interest. Cienciae Investigación Agraria, 35(1): 29-40. pp.

[2] Beyene T, David P. Ensuring small scale producers in Ethiopia to achieve sustainable an fair access to pepper market. Uganda Journal of Agriculture. 2007; 3(2): 113-119.

[3] Obidiebube EA, Eruotor PG, Akparobi SO, Emosaariue SO, Achebe UA, Kator PE. Response of four cultivars of pepper (Capsicum frutescens L.) to different levels of N, P and K fertilizer in rainforest Agro-ecological zone. Int. J Agric. Sci. 2012; 2(12): 1143-1150.

[4] Molla, T., Kassahun, Y., Melikamu, W. (2019): Evaluation of hot pepper varieties (Capsicum spps.) for yield related traits, quality and yield in Burie district, West Gojjam Zone, Ethiopia. International Journal of Plant Breeding and Crop Science 6(3): 581-588. Pp.

[5] Berhanu Yadeta, Derbew Belew, Wosene Gebresillase, Fekadu Marame. Variability, heritability and genetic advance in hot pepper (Capsicum annuum L.) genotypes in west Shoa, Ethiopia. American-Eurasian Journal of Agriculture and Environmental Science. 2011; 10(4): 587-592.

[6] Bosland PW, Votava EJ. Peppers, Vegetables and Spices Capsicum. CABI Publishing. New York, 2000: 198 p.

[7] Dessie, G., Birhanu, H. (2017): Growth and Yielding Potential of Hot Pepper Varieties under Rain-Fed Production at Woreta, Northwestern Ethiopia. International Journal of Research Studies in Agricultural Sciences (IJRSAS) 3(3): 1118. p. http://dx.doi.org/10.20431/24546224.0303002

[8] CSA (Central statistical agency, 2020). Agricultural sample survey 2019/2020. Vol. I. Report on area and production of major crops (private peasant holdings, meher season). Statistical Bulletin 584, Central Statistical Agency. Addis Ababa, Ethiopia.

[9] Sathiyamurthy, VA; Rajashree, V; Shanmngasundaram, T; Arumugam, T (2017). Effect of different mulching on weed intensity, yield and economics in chilli (Capsicum annum L.). Int. J Curr. Microbiol. App. Sci. 2017; 6(3): 609-617.

[10] Treder W, Klamkowski K, Mik A, Wojcik P (2004) Response of young apple trees to different orchard floor management systems. J Fruit Ornam Plant Res 12: 113-122.

[11] Alemu Hailiye and Ermias Abate, 2000. Horticultural crops production and associate constraints in North West Ethiopia. Working paper. Agricultural Economics Research Division. Agricultural Research Centere, Adet. P, 18.

[12] SAS Institute. (2009). Statistical Analysis Software user's guide. SAS Institute. Inc., Cary.

[13] Nsabiyera, V., Ochwo-ssemakula, M. & Sseruwagi, P. (2012). Field performance and quality traits of hot pepper genotypes in uganda. Afr. Crop Sci. J., 20(1) 123 – 139.

[14] Mochiah MB, Baidoo PK and Acheampong G, 2012. Effects of mulching materials on agronomic characteristics, pests of pepper (Capsicum annuum L.) and their natural enemies population. Agric. Biol. J. North Am. 3: 2253-2261.

[15] Norman, J. C., Opata, J. and Ofori, E. (2011). Growth and yield of okra and hot pepper as affected by mulching. Ghana Journal of Horticulture, 9: 35-42.

[16] Iftikhar, A., Zahoor H., Shuaib R., Noor-Un- Nisa, M. and Summar, A. N. (2011). Response of vegetative and reproductive components of chilli to inorganic and organic mulches. Pakistan Journal of Agricultural Science. Vol. 48(1), 19-24.

[17] Thakur, P. S., Anju Thakur and Kanaujia, S. P. (2000). Reversal of water stress effects 1. Mulching impact on the performance of Capsicum annuum under water deficit. Indian Journal of Horticulture 57(3): 250-254.

[18] Moniruzzaman, M. (2006). Effects of Plant Spacing and Mulching on Yield and Profitability of mulch in arid region of India. Agrochemica, 31: 183-202.

[19] Korir, N. K., J. N. Aguyoh and L. Gaoqiong, 2006.. Enhanced Growth and Yield of Greenhouse Produced Cucumber under High Altitude Areas of Kenya. Agricultura Tropica Et Subtropica, 39(4): 249-254.

[20] Alabi DA. Effects of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (Capsicum annuum L.). African J. Biotechnol. 2006; 5: 671–677.

[21] Venkanna, Y. (2008). Effect of mulches, organics and organic solutions on growth, yield and quality of chilli (capsicum annuum l.) Cv. Byadagi dabbi in northern transition zone of Karnataka. Thesis, University of Agricultural Science. Dharwad, Karnataka, India.

[22] Tan, YC; Lai, JS; Adhikari, KR; Shakya, SM; Shukla, AK; Sharma, KR (2009). Efficacy of mulching, irrigation and nitrogen applications on bottle gourd and okra for yield improvement and crop diversification. Irrig. Drain. Syst., 23: 25-41.

[23] Olarewaju JD, Showemino FA. Agronomic indices of drought tolerance in sweet Pepper. Proceedings 24th Hort. Conference. 17-22 September Bosland. P. W. and E. J. Votava, 2000. Peppers, Vegetables and Spices Capsicum. CABI Publishing. New York, 2006; 198. India.

[24] Liasu, M. O. and A. K. K. Achakzai, 2007. Influence ofTithonia diversifolia Leaf mulch and fertilizerApplication on the Growth and Yield of Potted Tomato Plants. American-Eurasian J. Agric. and Environ. Sci., 2(4): 335-340.

[25] Barchenger DW, Clark III RA, Gniffke PA, Ledesma DR, Lin S, Hanson P and Kumar S, 2018. Stability of Yield and Yield Components of Pepper (Capsicum annuum), and Evaluation of Publicly Available Predictive Meteorological Data in East and Southeast Asia. HortSci. 15(12): 1776-1783.

[26] Vos, J. G. M. and Sumarni, N. (1997). Integrated crop management of hot pepper (Capsicumspp.) under tropical lowland conditions. Effects of mulch on crop performance and prediction. Journal of Horticultural Science. 72: 415-424.

[27] Khandaker MM, Rohani F, Dalorima T and Mat N, 2017. Effects of different organic fertilizers on growth, yield and quality of Capsicum annuumL. var. Kulai (red Chilli Kulai). Biosci. Biotech. Res. Asia. 14: 185-192.

[28] Fekadu Marame, Dandena Galmesa. Status of Vegetable Crops in Ethiopia. Ugandan Journal of Agriculture. 2006; 12(2): 26-30.

[29] Dzomeku, IK; Mahunu, GK; Bayorbor, TB; ObengDanso P (2009). Effects of mulching on weed control and yield of hot pepper and tomato in the Guinea savannah zone. Ghana J. Hortic., 7: 53-61.

[30] Hassan FA, Ali EF, Mahfouz SA. Comparison between different fertilization sources, irrigation frequency and their combinations on the growth and yield of Coriander plant. Aust. J. Basic & Appl. Sci., 6(3): 2012; 600-615.