Ghana Journal of Science, Technology and Development | Vol. 8, Issue 2, December 2022
e-ISSN: 2343-6727
Received: March 30, 2022
Accepted: September 15, 2022
DOI: https://doi.org/10.47881/322.967x

Preliminary study on the Effect of NPK (15-15-15) fertilizer and plastic mulch on growth and yield of three chili cultivars grown in field and pot conditions

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ABSTRACT

The study was conducted to investigate the effect of Black Plastic Mulch (BPM) and different rates of NPK (15:15:15) fertilizer on the growth and yield of three chili cultivars under field and protected cultivation. Two levels of mulch (BPM and no mulch), three levels of NPK (0, 200 and 300 kg/ha), and three cultivars "Demond F1" (DF1), "Legon 18" (L18), and "Shito Adope", (SA) were used. Split application of half of each of the 200 and 300 kg/ha rates were applied two and four weeks after transplanting. Vegetative growth indices, soil moisture, and soil temperature were measured at 2, 4, 6, 8, and 10 weeks after transplanting. The yield was calculated using AVRDC (1990) formula for chili pepper. The study revealed an increase in soil temperature and moisture under BPM for both studies. Also, 200 kg/ha NPK and BPM led to an increase in vegetative growth and yield for DF1 and SA. However, 300 kg/ha NPK decreased vegetative growth. In addition, there was no significant influence of BPM on the number of fruits harvested. However, for the pot study, BPM led to an increase in the number of fruits for "Legon 18" as compared to the other cultivars. The study, therefore, concludes that 200 kg/ha NPK was the best when cultivating DF1 and SA, for chili growth and development in the savannah ecological zone.

Key words: *Plastic Mulch, NPK fertilizer rates, chili cultivars, soil moisture, yield.*

INTRODUCTION

Different cultivars of chili are usually cultivated in Ghana, but the most popular cultivars are "Shito Adope" and "Legon 18". "Demond F1" is an exotic variety that is gradually becoming popular in Ghana. However, these cultivars have not been evaluated to ascertain their productivity with different Nitrogen, phosphorus and Potassium (NPK 15-15-15) fertilizer rates and Black Plastic Mulch (BPM) under the conditions of the Savannah ecological zone.

Chili can be cultivated across Ghana, but the climatic conditions in the Derived Savannah zone are considered the most suitable for hot pepper production (GTZ, 2009). The average yield of hot peppers from farmers' fields in the Northern Region has declined from 8.30 Mt/h (FAOSTAT 2010), to a reduction in 2013 (5.2 Mt/h) and now (4.8 Mt/h) in 2015 (Shu-aib et al., 2019) while the potential yield of pepper remains 32.30 Mt/h (FAOSTAT 2010), which is achievable with the application of good agricultural practices (GTZ, 2009). Nigeria has, also observed a decreased in yield from an average yield of 1.021 Mt/h (Alegbejo et al., 2006), to 8.33 Mt/h FAOSTAT (2012)

The low yield from farmers' fields including those in Northern Ghana has been attributed to the use of low-yielding cultivars, poor soil fertility, and inadequate soil moisture, especially during the dry season as well as the reduction in agricultural land (Nyarko et al. 2011; GTZ, 2009; Amuzu, 2011; Bosland and Votava 2000; Norman, 1992; Fernando and Juan 2013)

The low yield and poor quality of chili peppers in the northern region are likely to be improved by improving soil fertility with appropriate fertilizer rate and maintaining adequate soil moisture with BPM. Singh et al. (2003); Olaniyi and Ojetavo (2010) propose that NPK is one of the fastest and easiest ways to increase yield. Numerous studies have revealed increased in soil moisture with PM (Gough, 2001 and Gough, 2001).

The yield of pepper usually obtained by farmers in Ghana is lower than the potential yield, mainly due to poor soil fertility. It is estimated that pepper growers in Ghana obtain only about 50% of the attainable yields. The need to apply technologies that can improve soil fertility and S moisture for improved growth and yield of the crop becomes a necessity (MiDA, 2010). The need to apply technologies that can improve soil fertility and soil moisture for improved growth and yield of the crop in the study area becomes a necessity. The current study was conducted based on the hypothesis that an appropriate NPK (15-15-15) rate and the use of BPM can improve soil conditions, as well as growth and yield of chili pepper in the northern region of Ghana. The main objective of this study was therefore to determine the interaction effect of different rates of NPK (15-15-15) and BPM on the growth and yield of three chili cultivars.

MATERIALS AND METHODS

Description of the experimental site

Nyankpala is within the Guinea Savannah Agro Ecological Zone and is located at latitude 09o25oN and longitude 09 58'W, 183 m above sea level. The soil within the study area is an alfisol under the USDA system of classification (NAES, 1986).

Experimental Design and Treatments

Soil analysis for pH, CEC, total N, available P, K, and C was carried out at the Savannah Agriculture Research Institute (SARI) Nyankpala. soil samples were sieved through a 2 mm sieve to get rid of gravel, roots, and other debris. Insecticide (a.i. cyhalothrin) was obtained from Wumpine agro chemicals shop (Tamale) and sprayed on the newly emerged seedlings against insect pests attack at 250 g /l and (0.02 Ib ai /A) and 2 weeks after emergence (U. S environmental protection Agency 2020 guide lines) 54 12-L plastic pots with 30 cm top diameter were used for the experiment.

BPM was used to cover the surface of the soil in pots designated for mulch. Five (5) cm openings were made at the centre of the plastic films for the transplanting holes. Pots were watered to field capacity using the method described by Michael et al. (2017) and allowed to stand for 24 hours before transplanting a plant per pot. Weed control by hoeing and hand pulling at two (2) week intervals. The field crops were rain-fed, i.e., dependent on rainfall, while one (1) litre of water was supplied to pot plants when required.

Data collection

Data on vegetative indices, soil moisture, and soil temperature were measured at 2, 4, 6, 8, and 10 weeks after transplanting. Plant height was measured from the base of the stem to the apex of the plant using a meter rule. A digital balance was used to measure weights of fruits and the average weight recorded for each treatment. The length of each fruit was measured from the pedicle to the apex using a Vernier caliper and the average of the 12 fruits was taken for the cultivars. The yield for the cultivars was calculated using AVRDC, (1990) formula for calculating chili pepper. Soil moisture was measured with a Soil moisture meter. (Field Scout TDR 100, ST FieldScout TruFirm, Centaur Asia Pacific) at three (3) different points on each plot. S temperature was measured (I-power Digital Thermometer – Shanghai Hugespecial Electronic Co., Ltd Zhejiang, China) at 3 different points on each plot at 13: 00 GMT on each occasion. A Minolta chlorophyll meter (SPAD 502) was used to measure SPAD Value.

Data analysis

Data collected were subjected to Analysis of Variance (ANOVA) using the Genstat Statistical package, 12th edition. Means were separated using Least Significant Differences (LSD) at a 5 % confidence level.

RESULTS

Initial soil analysis

Table 1: Initial soil analysis of project site.

Soil parameter	Level (ppm)
pH	5.98
CEC	208 µs
Organic carbon	0.89 %
Nitrogen	0.49 mg / kg
Phosphorus	2.4 mg / kg
Calcium	4.7 mg / kg

The initial soil analysis (table 1) showed that the soil contains 0.49 mg/kg of N, the available p is 2.4 mg/kg whiles C is 0.89 %, K has 47 mg/kg, and the CEC present in the soil is very high with 208 µs part per million (ppm) proportion and the available pH is 5.98.

Soil temperature

Mulch x variety; and NPK rates x mulch interactions for 10 weeks significantly ($P < 0.05$) affected soil temperature in pots and under field study (Figure 1 and Table 2 respectively).

Soil moisture

Only mulch x variety interaction significantly ($p = 0.036$) affected soil moisture. The highest soil moisture was recorded under BPM for all the cultivars as compared to the pot study (Table 3).

Vegetative growth indices for field and pot study

Plant height

The main effect of mulch over 8 weeks was significant for the field study (Figure 3). For the pot experiment, only Mulch x Variety and Fertilizer x Variety interactions significantly affected plant height.

Number of leaves

Compared to the other treatments, SA at the various NPK rates and L18 treated with 200 Kg/ha NPK had more leaves (Table 4). In the field experiment, DF1 produced the fewest leaves when it was applied with various fertilizer rates. Among the fertilizer rates used for the variety, L18 received the application of 300 kg/ha, which resulted in the most leaves.

Number of branches

Only the field experiment, variety affected ($P < 0.05$) the number of branches. The L18 and SA plants produced the highest number of branches and DF1 plants the least. Plants in plots without mulching had a higher number of branching than those planted on BPM.

Stem diameter

L18 on BPM plots had the widest stem diameter compared with SA and DF1 in the BPM and the control plots. 200 kg/ha had a wider stem diameter for DF1 and SA. The main effects of mulch were also significant (p = 0.001) as presented in Table 5.

SPAD meter value

The main effects of mulching on the SPAD value of plants over ten weeks were significant. Plants without mulch had a higher SPAD values than plants with PM at 6 weeks after transplanting. Figure 8). However, at 10 weeks after transplanting, plants with BPM had higher SPAD meter values as compared to the non-mulched plants in both studies (Figure 9).

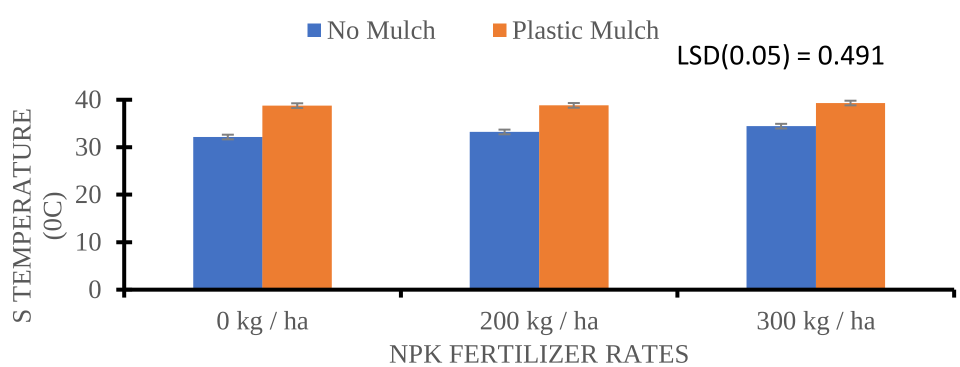

Figure 1: Interaction effect of NPK fertilizer rates x Mulch on S temperature under field condition

Error bars represent ½ LSD (0.05%)

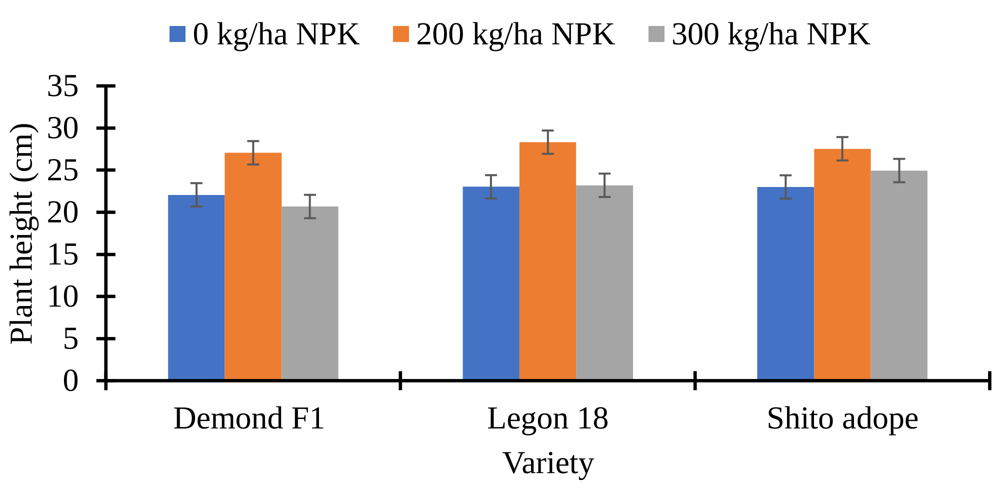

Figure 2: Effect of NPK (15-15-15) Fertilizer x Variety interaction on the height of chili pepper

Error bars represent ½ LSD (0.05%)

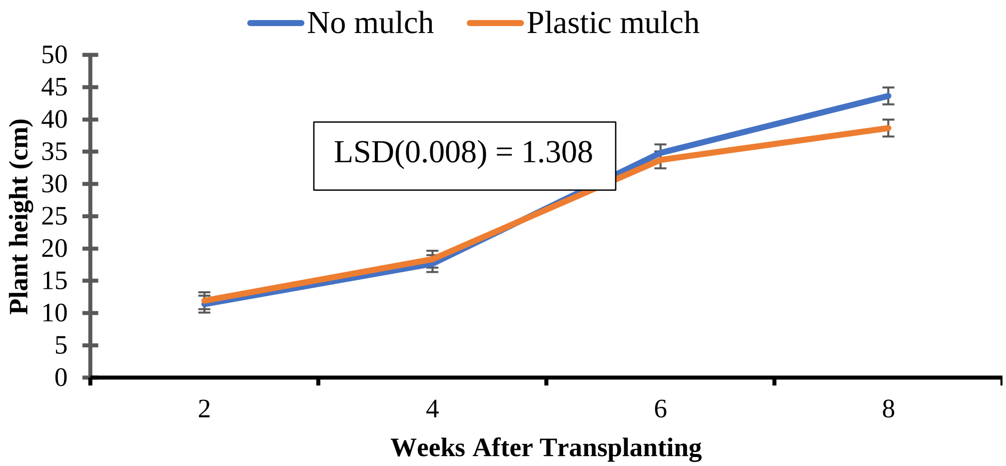

Figure 3: Effects of black plastic mulch on plant height with time
Error bars represent ½ LSD (0.05%)

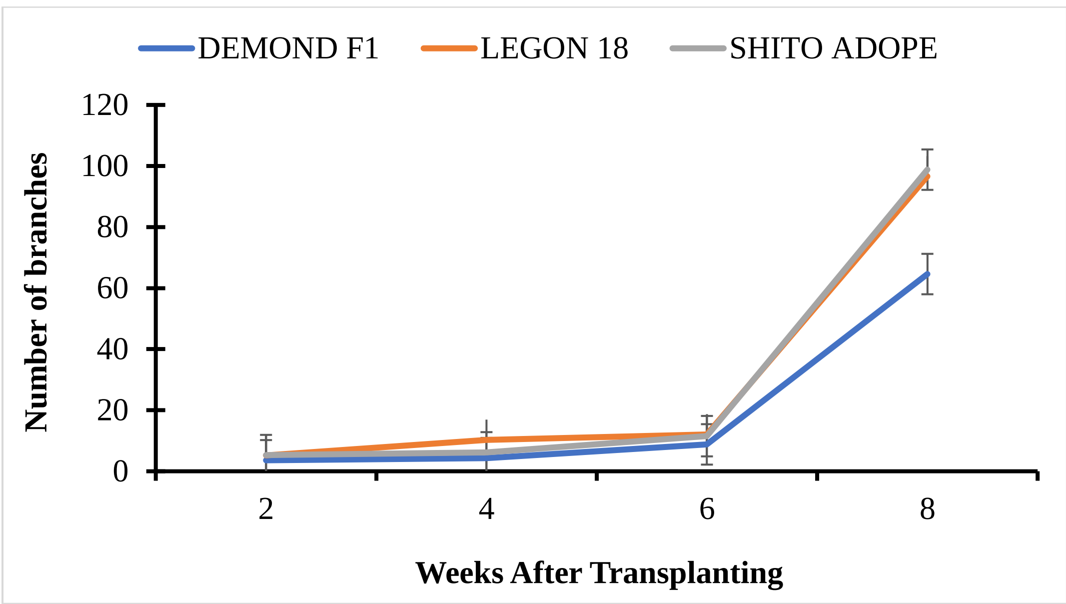

Figure 4: Variation in the number of branches among three chili pepper cultivars for field
Error bars represent ½ LSD (0.05%)

Lsd (0.002)= 3.31

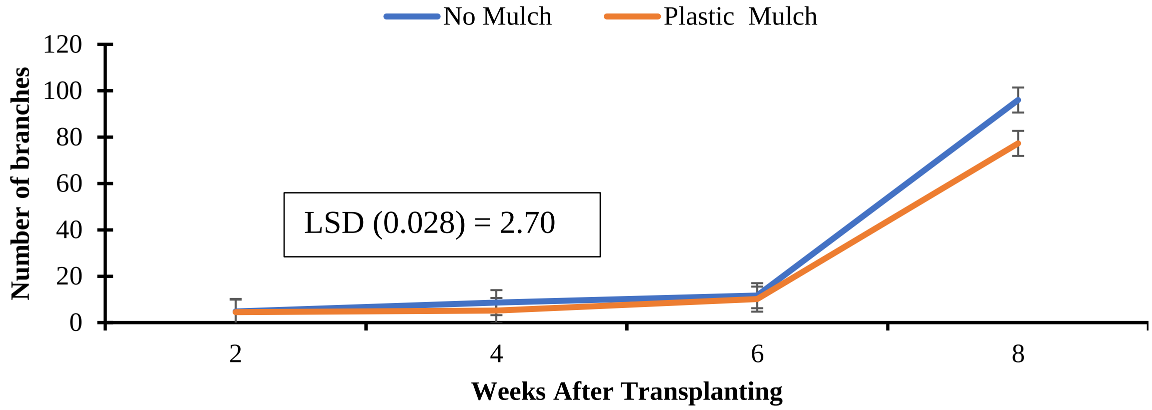

Figure 5: Effect of mulching on number of branches in chili pepper for field
Error bars represent ½ LSD (0.05%)

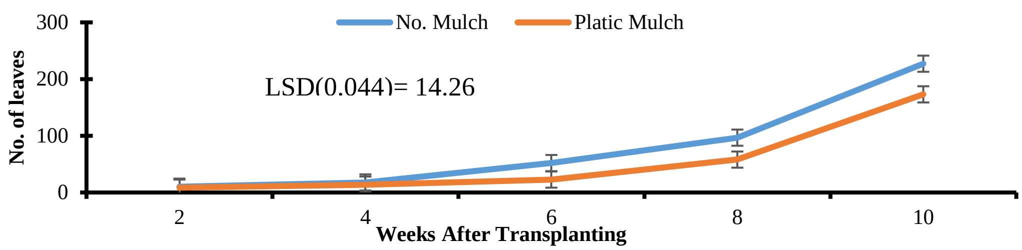

Figure 6: Main effect of mulch on number of leaves of chili pepper for field
Error bars represent ½ LSD (0.05%)

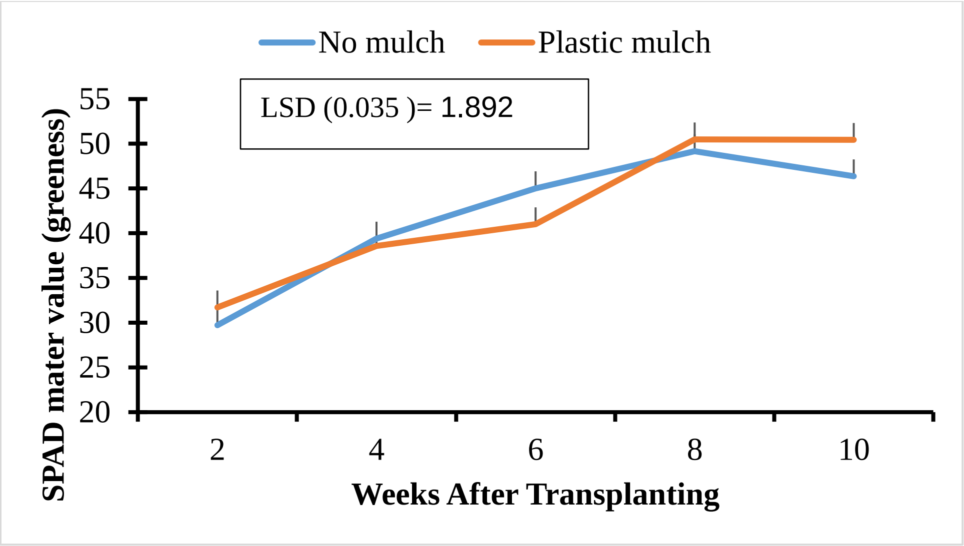

Figure 7: Main effect of mulch on SPAD meter value
Error bars represent SED (0.05%)

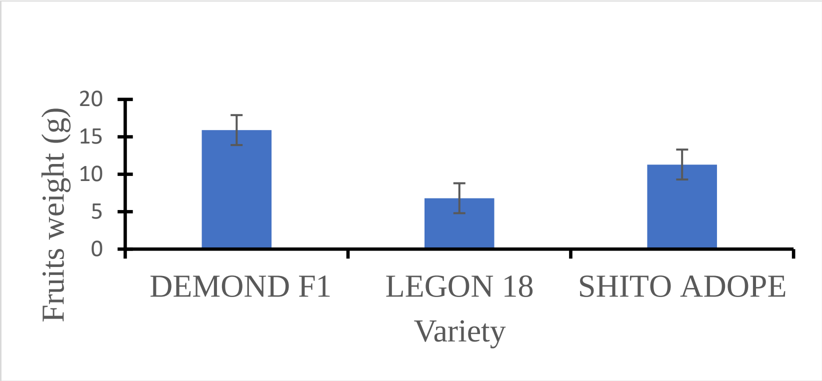

Figure 8: Main effects of variety on fruit weight for pot
Error bars represent SED (0.05%)

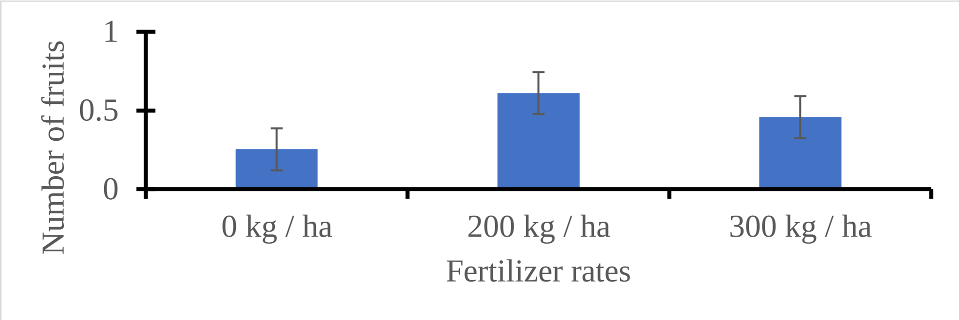

Figure 9: The main effect of NPK rates on number of fruits for pot

Error bars represent ½ LSD (0.05%)

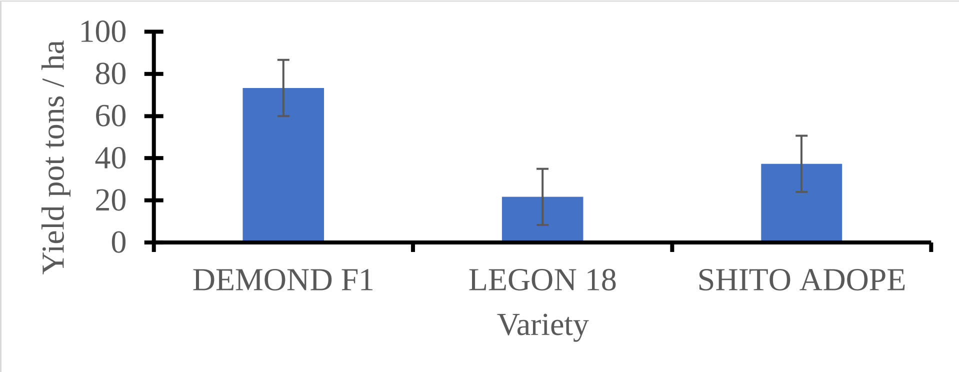

Figure 10: Main effects of variety on yield for pot
Error bars represent ½ LSD (0.05%)

Yield and yield components
The main effects of variety for both studies and fertilizer for pot study showed a significant ($P<0.05$) difference (Figure 9 and tables 7 and 8) for the experiment. DF1 had the highest number of fruits whiles L18 had the least amount of fruits per plant in both experiments.

Only the main effects of NPK rates in both studies significantly affect fruit weight.

Application of 200 kg/ha NPK resulted in higher fruit weight which was similar to 300kg/ha in both cases. The highest fruit yield was obtained when 200 kg/ha NPK was applied to the crops as compared to the other rates (Tables 7; 8 and Fig 10). For cultivars, DF1 gave the highest fruit yields whilst L18 produced the least yield (Fig 10). L18 had the longest fruits for the field. DF1 and SA had similar fruits length (Table 8). For the pot study, only the main effects of fertilizer significantly influenced the fruit length. The longest fruits were produced with 200 kg/ha NPK whiles 0kg/ha led to the shortest fruits in all the cultivars. With diameter, only the main effects of variety was significant. L18 had the widest fruit diameter whiles SA had the least fruit diameter (Table 7 and Table 8).

Table 2: The interaction effects of mulch and variety over 10 weeks on S temperature under field

MULCH	VARIETY	WEEK				
		2	4	6	8	10
No mulch	DEMOND F	31.57	36.09	31.76	36.91	41.09
	LEGON 18	31.67	36.45	32.33	35.55	45.15
	SHITO ADOPE	32.11	36.28	32.03	35.45	44.61
Plastic mulch	DEMOND F1	33.82	40.32	33.96	37.26	47.85
	LEGON 18	33.37	40.34	34.29	36.91	50.85
	SHITO ADOPE	34.23	41.04	33.85	36.83	44.08
p = 0.005 LSD=2.166						

Table 3: Mean treatment effects on growth parameters under field and pot Studies

Mean growth parameter for field study					Mean growth parameter for pot study			
Treatment		Mean N leaves	Mean Stem dia(cm)	Mean soil Moist (%)	Treatment		mean Plant height(cm)	Mean soil Moisture (%)
M	V				M	V		
M0	DF1	0.26	36.15	5.56	M0	DF1	17.84	8.22
	L 18	0.23	36.22	6.62		L 18	17.42	8.64
	SA	0.24	35.44	8.96		SA	20.68	9.30
BPM	DF1	0.25	38.76	5.64	BPM	DF1	20.17	9.22
	L 18	0.31	38.82	6.64		L 18	19.46	9.71
	SA	0.23	39.31	6.70		SA	18.63	9.44
SED			0.491	0.33	SED		1.108	0.52
DF			34	34	DF		34	34
PROBA		<.001	0.001	<.001	PROBA		0.009	0.021

Where M denote mulching: M0 = No mulch, BPM = Black plastic mulch; V = Variety; DF1= Demond F1; L 18= Legon 18; SA = Shito Adope ; F denotes Fertilizer: F1 0 kg / ha; F2= 200 kg / ha and F3= 300 kg / ha; SED = Standard errors of differences in means ; LSD (0.05%) = Least significant differences of means; CM = centimers; ^{0}C =Degree Celciuse

Table 4: Mean interaction Effects of variety and NPK Fertilizer on growth and SPAD meter value for field and pot study

Mean interaction of growth and SPAD value for field study					Mean interaction of growth and SPAD value for pot study					
TRT		Mean Plant hight (cm)	Mean Number of leaves	Mean SPAD Value	Treatment		Mean Plant hight (cm)	Mean Number of leaves	Mean Diameter (cm)	Mean SPAD Value
V	F				V	F				
DF1	0	26.13	5.97	24.80	DF1	0	18.60	42.4	0.35	40.19
	200	30.01	5.55	24.51		200	19.35	67.9	0.40	42.62
	300	26.89	5.30	21.40		300	19.08	66.4	0.42	40.00
L18	0	28.68	6.59	22.16	L18	0	17.97	79.7	0.45	42.42
	200	28.32	7.49	25.93		200	18.28	52.8	0.41	42.53
	300	27.54	5.82	24.99		300	19.07	86.4	0.44	46.53
SA	0	20.68	7.88	27.21	SA	0	18.67	67.2	0.44	39.06
	200	23.20	7.48	24.13		200	23.48	90.2	0.52	45.63
	300	24.95	8.13	22.81		300	16.83	59.0	0.37	40.73
SED		1.38	0.41	11.40	SED		1.357	0.41	0.05	1.79
DF		34	34	34	DF		34	34	34	34
PRO		0.02	0.002	0.015	PRO		0.002	0.002	0.005	<.001

Where M denote mulching: M0 = No mulch, BPM = Black plastic mulch; V = Variety; DF1= Demond F1; L 18= Legon 18; SA = Shito Adope; F denotes Fertilizer: F1= 0 kg / ha; F2= 200 kg / ha and F3= 300 kg / ha; SED = Standard errors of differences of means; LSD (0.05%) = Least significant differences of means; PRO =probability; TRT = Treatment

Table 5: Mean main effect of treatment (Mulch, Variety and fertilizer) on growth parameters and SPAD meter for field condition

Mean main effects of growth parameters and SPAD meter value		
Treatment	**Mean stem diameter (cm)**	**Mean SPAD value**
Mulch		
M0	0.2479	155.5
BPM	0. 4452	149.7
SED	0.00912	2.69
Df	34	34
Probability(*P*)	0.027	0.031
Treatment	**Mean plant height(cm)**	**Mean stem diameter (cm)**
Variety		
DF1	27.68	0.2585
L 18	27.68	0.2585
SA	27.68	0.2585

SED	0.801	0.01116
Df	34	34
Probability	<.001	0.010
Treatment	**Mean plant height cm)**	**Mean stem diameter**
Fertilizer		
0 Kg/ha	25.16	*
200 Kg/ha	27.18	*
300 Kg/ha	26.46	*
Sed	0.801	*
Df	34	*
Probability	0.042	*

Where M= mulching: M0 = No mulch, BPM = Black plastic mulch; V = Variety; DF1= Demond F1; L 18= Legon 18; SA = Shito Adope; F= Fertilizer: F1 0 kg / ha; F2= 200 kg / ha and F3= 300 kg / ha

SED = Standard errors of differences of means; LSD (0.05%) = Least significant differences of means

PRO =probability; ***= mean effect not significant.

Table 6: Interaction effects of fertilizer rates and variety on SPAD meter value over time.

NPK Fertilizer Rates	Variety	Week			
		2	4	6	8
0 kg / ha	DF1	43.2	47.1	26.91	22.16
	L18	45.9	52.2	23.81	21.51
	SA	41.7	47.8	22.1	21.4
	DF1	44.2	50.9	27.5	24.8
200 kg / ha	L18	43.9	56.8	28.3	25.9
	SA	38.1	53.2	27.8	24.9
	DF1	42	49.8	27.5	27.2
300 kg / ha	L18	43.2	53.9	26.8	24.1
	SA	42.3	55.3	27.6	22.8

P = .015
LSD (0.05%) = 22.54
SED= 11.40

Table 7: Mean main effects of fertilizer on yield and yield component for three chili variety

Mean main effects of fertilizer on yield and yield component for field						Mean main effects of fertilizer on yield and yield component for POT					
Trt	**No. of fruit**	**Fruit Wt/ (g)**	**Yield Ton/ ha**	**Fruit length (cm)**	**Fruit Diameter (cm)**	**Trt**	**No. of fruit**	**Fruit wt / Bed**	**Yield Tons/ ha**	**Fruit length**	**Fruit diameter**
F						**F**					
0	*	32.8	0.22	*	*	0	4.6	5.9	0.25	5.56	1.05
200	*	47.6	0.60	*	*	200	10.6	14.0	0.61	6.28	2.47
300	*	45.9	0.41	*	*	300	10.1	14.0	0.45	5.77	2.73
Sed	*	5.59	13.3	*	*	Sed	1.95	3.22	13.34	0.27	0.27
Df	*	36	36	*	*	Df	36	36	36	36	36
Probability	*	0.02	0.03	*	*	Prob	0.007	0.023	0.036	0.037	0.002

F denotes Fertilizer: F1 0 kg / ha; F2= 200 kg / ha and F3= 300 kg / ha, FW=fruit weight /g, Trt= treatment; LSD (0.05%) = Least significant differences of means; SED = Standard errors of differences of means; **** = mean main effects not significant

Table 8: Mean main effects of cultivars to yield and yield component for field study

Field yield				
Treatment	No. of fruits/ plant	Yield Tons/ha	Fruit length (cm)	Fruit diameter (cm)
Variety				
D F1	29.4	6.0	5.64	2.48
L 18	20.5	2.0	6.40	3.26
SA	28.1	3.7	5.70	1.60
SED	3.12	13.34	0.41	0.17
Df	36	36	36	36
Probability	0.009	0.001	0.022	0.002

DISCUSSION

Initial Soil Analysis

The findings (Table 1) of the initial soil test were consistent with the study of Shaibu et al., 2017 and that of Abubakari et al., (2018) on the same study location. However, the nitrogen was higher in this finding than what Abubakari et al., (2018) obtained. The differences in the physico- chemical properties in the field could be as a result of the accumulation effects of continues application of organic and inorganic fertilizer used by students on experimental field.

Effects of NPK and mulch on Soil temperature and Soil moisture

The increase in soil temperature and moisture with the application of black plastic mulch (BPM) could be attributed to the fact that the period of cultivation corresponded with high environmental temperature and very low rainfall. The higher environmental temperatures recorded during the period of study was 39.1^0 C for the field and 42.8^0C for pot with a prolong draught (SARI meteorological service 2016/17; appendix 1). The temperature recorded under the BPM may have adversely affected the growth of plants. Higher temperatures tend to affect plants' growth by inhibiting root growth, which affects the growth above ground. An earlier study showed that high temperatures generated under black plastic film could cause "scorching" of young plants (William, 1993). Many studies indicate that BPM has the potential in retaining less temperature in the S than silver colour mulches, transparent and translucent mulches (Dodds et al., 2003; Streck et al. 1995; (Rosenberg, 1974). The reasons for which this study employed BPM. The finding is consistent with the study of Dodds et al., (2003) which stated that BPM is the most preferred plastic mulch used in the cultivation of vegetables in areas where temperatures are cold.

The effect of BPM on soil moisture can be attributed to the fact that it prevents evaporation of moisture from the soil. Previous research has found that PM can retain moisture and prevent it from evaporating from soil (Abu-Awwad, 1998).

NPK is known to promote plant growth and increase the number and length of internodes, which progressively increases plant height. The study revealed an increase in plant height for both field and pot studies with the application of 200 kg/ha NPK. However, Shito adope generally,was observed to be shorter than the other cultivars even when the same amount of NPK was applied.

The application of 300 kg/ha of NPK led to a decrease in stem diameter, branches, and number of leaves for the cultivars in both field and pot studies. This is probably due to the fact that the additional nutrients might have led to excess nutrients in the S, which probably were toxic to the crop. Cultivars L18, DF1 and SA showed significant variations in vegetative parameters such as plant height, number of branches, and stem diameter. This finding agrees with the findings of Kulvinder and Srivastova (1988), who stated that plant height increased with increasing rates of fertilizer application.

The retardation in the vegetative growth of plants under BPM was probably due to excessive S temperature within the root zone. preventing nutrient uptake by plants and other physiological activities. These findings agree with Lamont et al. (2005) who found that in warm environments, BPM is effective for increasing S temperature. Nitrogen is an integral part of the structure of the chlorophyll that is responsible for the greenness of plant leaves. The increase in the SPAD meter value with an increase in NPK from 200 kg/ha to 300kg/ha is as a result of the relatively higher concentration of nitrogen. The SPAD meter value for greenness may depend on the cultivar, NPK, and biomass (Olaniyi and Ojetayo 2010). This finding agrees with the study of Westerveld et al. (2004) and Soval-Villa & Co. (2002). The greenness of leaves at the flowering and fruiting stages of a plant depends on the developmental stages of the plant. This agrees with findings by Peng et al. (1993), who reported that SPAD meter readings vary greatly depending on the growth stage of a crop. Nutrients like nitrous oxide (N P K) have been shown to increase the SPAD meter value and 200 kg/ha NPK application in crops grown in Nigeria. This is consistent with findings of Panchal et al. (2001) and Olaniyi and Ojetayo (2010) who discovered that plants require nutrients like N P K in the right quantities for optimum crop production.

Yield components

Yield of L18 could be associated with the controlled environment that boosted pollen and anther development and increased pollen viability, which consequently increased the number of fruits. Protected cultivation can lessen biotic and abiotic stress. The issue of reduced productivity during extreme weather conditions may be resolved by protected cultivation. BPM might not have contributed directly to the yield of chili, which could have led to a lower yield. Brown et al. (1996) study agree with this finding as they reported that BPM did not harm summer squash yields compared to bare ground treatments. Caldwell and Clarke (1999) also found no difference in yield with BPM. The increased vegetative growth of DF1 under BPM did not translate into an increased number of fruits in the experiment. Plants grown without BPM had an increased amount of fruits for DF1 than those grown on BPM plots. The reduction could be as a result of the fact that prolonged drought and high temperatures resulted in excessive retention of heat by the BPM.

Overly wet soil can stress plants by reducing oxygen in the soil, harming the thin root hairs, and preventing the root system from absorbing water. Also, due to its impacts on plant phenology, phasic development, growth, assimilate partitioning, plant reproduction processes, and root development, soil moisture stress can have a negative impact on crop yield. The study again showed an increase in yield for DF1 of 200 kg/ha. The highest number of fruits and yield might be due to the vigour of plants and increased biomass. This could be related to the maximum utilization of NPK by DF1 and a reflective performance in the SPAD value and biomass.

Pepper productivity is highly responsive to NPK fertilizer. Tumbare and Niikam (2004) found that nitrogen fertilizer increased fruit weight, yield, and fruit number in chili peppers. An increase in NPK to 300 kg/ha, on the other hand, had no effect on the number of fruits harvested.

Pepper, like any other crop, performs best in a favourable environment. The delays in fruiting in the pot study could be attributed to high- environmental temperature (42.80C) (SARI meteorological service 2016/17), at the time of study. This is also in line with the findings of Elsevier (2017) who indicated temperature variation as a contributing factor to the pollination and fruiting of crops. which might have influenced pollination in flowers, hence a delay in fruiting (Shu- aib et al., 2017). The increase in fruit length and diameter for L18 in both studies could be attributed to the genetic trait of L18 and the application of 200 kg/ha NPK. This finding is in support of Buzetti *et al*. (2007) that NPK increases fruit length and width. It has also been reported that an increase in N application resulted in maximum fruit length and diameter of cucumbers (Ahmed *et al*., 2007; Roy *et al*., 2011; Grubben and Tahir, 2004) and variation in purity and quality of the genetic materials (Dzomeku et al., 2016).

Conclusion

The application of black plastic mulch (BPM) resulted in a drastic increase in soil temperature and soil moisture for field and pot studies, which subsequently decreased the vegetative growth of the cultivars.

However, the study revealed an increased in the number of fruits for Legon 18 and Demond F1 as compared to Shito Adope with the application of BPM. 200 kg/ha NPK led to an increase in the vegetative growth (except stem diameter) of the plants in all the cultivars. However, vegetative growth decreased when the application of NPK (300 kg/ha) was made in both studies. Further, BPM and 200 kg/ha interaction resulted in the maximum number of fruits and yield in all the cultivars under field and pot conditions.

Acknowledgment

This study was technically supported and partially financed by GhanaVeg in collaboration with International Fertilizer Development Center of the Northern and West Africa Division

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