

Growth and Yield of Chilli (*Capsicum annuum* L.) in Response to Mulching and Potassium Fertilization

SITI AISHAH HASSAN, R. ZAINAL ABIDIN and M.F. RAMLAN

Department of Agronomy and Horticulture,
Universiti Pertanian Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Keywords : potassium, mulch, chilli

ABSTRAK

Kajian di ladang telah dijalankan untuk menentukan kesan kadar baja kalium (0, 66 dan 132 kg ha⁻¹) dan jenis sungkupan (plastik hitam, plastik pantul cahaya dan pelepah kelapa) keatas pertumbuhan dan hasil cili. Ketinggian pokok, berat hasil, bilangan buah dan berat kering pokok, berat hasil, bilangan buah dan berat kering pokok meningkat dengan pertambahan kadar K dan penggunaan sungkupan. Hasil meningkat sebanyak 89% dan 142% masing-masing pada kadar 66 dan 132 kg ha⁻¹. Hasil tertinggi didapati dengan penggunaan sungkupan plastik pantul cahaya. Kandungan N,P,K dan Ca dalam tisu daun, suhu dan kelembapan tanah didapati lebih tinggi dengan sungkupan berbanding tanpa sungkupan. Terdapat positif korelasi di antara berat kering pokok dengan suhu dan kelembapan tanah.

ABSTRACT

A field experiment was conducted to study the influence of levels of potassium fertilizer (0, 66 and 132 kg ha⁻¹) and types of mulching (black plastic, reflective plastic and coconut fronds) on growth and yield of chilli. Plant height, yield, fruit number and dry weight of plant increased with increasing K levels and mulching. Yields were increased by 89% and 142% with K levels of 66 and 132 kg ha⁻¹, respectively. Highest yield was obtained from plant grown under reflective plastic mulch. Nitrogen, P, K and Ca content in leaf tissues, soil temperature and moisture under mulched conditions were higher than without mulch. There was a positive correlation between plant dry weight with soil temperature and moisture.

INTRODUCTION

The advantages of mulching in vegetable crop production have been well documented. Various mulching materials are utilized and these include weed or grass clippings, paddy straw, bark, sawdust and plastic. Mulches can effectively minimize water vapour loss, soil erosion, weed problems and nutrient loss (Mitsuo and Le, 1978; Van Derwerken and Wilcox, 1988; Clough *et al.*, 1990). The most common response to mulch is an increase in total yield (Locascio *et al.*, 1985; Wien and Minotti, 1987; Van Derwerken and Wilcox, 1988). The reflective plastic mulches can reduce the incidence of aphid-borne viruses and exclude some species of pest (Schalk *et al.*, 1979).

Little information is available concerning the use of mulches in Malaysia although its application has been gradually expanding. Most

local vegetable farmers use plastic and plant residue mulching. The current recommended rates of fertilizer for chilli are normally for planting system without mulching. However, mulches are already known to be effective in reducing nutrient losses through leaching (Schales and Sheldrake, 1965). This experiment was conducted to determine the effect of various K rates and mulching materials on the growth and yield of chilli.

MATERIALS AND METHODS

The experiment was conducted on sandy clay loam soil. The experimental design was a split-plot with four replications. Main plots were treated with potassium at rates of 0, 66 and 132 kg K/ha, while subplots were treated with mulching materials consisting of black plastic, reflective plastic and coconut fronds. Each single row

subplot contained 10 chilli plants (*Capsicum annum* cv. MC4) spaced 50 cm within the row and 60 cm between rows.

Other than K, all plots received 140 kg N/ha and 70 kg P/ha. All P, K and 70 kg N/ha were applied broadcast and incorporated into the soil followed by application of herbicide. The remaining N was applied six weeks after transplanting. Mulches were laid down within a day after fertilizer application. Three layers of coconut fronds were used to cover the total soil surface. Uniform sized seedlings were transplanted manually. Water was supplied when necessary by overhead sprinkler irrigation. Weeds on bare ground plots were removed manually and those grown between the plots were sprayed with paraquat.

Soil temperature and moisture were measured at 10 cm depth at two-week intervals. Soil temperature was determined by using a soil probe thermometer. A composite of 5 soil cores from each plot was randomly sampled, weighed and oven-dried at 105°C for 24 hrs and reweighed to determine the percentage of moisture. The newly-expanded leaves were taken from each of the eight plants in a replication and combined into one sample for that replication for nutrient analyses. Nutrient contents were determined by using Technicon Auto-analyser II.

Fruits were harvested at red-turning and ripe stages at 3-4 day intervals beginning Week 9 after transplanting and continued for 6 weeks.

Fruits were counted and graded into marketable and culled (deformed, diseased and rotten) groups. The marketable fruits were weighed and recorded as total fresh weight. At the last harvest, plants were pulled out and their dry weight minus fruits determined. Plant height was measured at 12 weeks after transplanting.

RESULTS

No significant interaction of K rates with mulching materials was observed in any of the measured parameters; thus, only main effect data are reported. Plant height and weight of mulched plants were significantly higher than those without mulches (Table 1). However, neither parameter was affected by type of mulching. Plant height increased with increased K fertilizer rates. Similar results were obtained for plant weight.

With mulching, both marketable fruit weight and total fruit number were higher than those without mulching (Table 2). Yield was highest with reflective plastic mulch. Marketable fruits from plants grown under black plastic and coconut frond mulch were not significantly different. However, the number of fruits for plants grown under black plastic mulch was 28% higher than those grown under coconut frond mulch. Average weight per fruit was not significantly affected by mulching.

Potassium fertilizer rates influenced yield (Table 2). Lowest yield was obtained without K fertilizer application. Yield increased by 89% and 142% with K levels of 66 and 132 kg k/ha,

TABLE 1
Influence of K fertilizer rates and mulches on height and dry weight of chilli plants

Treatment	Plant height (cm)	Plant dry weight (g)
Mulch		
None	47.74b	36.86b
Black plastic	56.31a	57.58a
Reflective plastic	54.51a	57.84a
Coconut fronds	58.58a	57.12a
K (kg ha ⁻¹)		
0	50.25c	41.30c
66	57.22b	51.83b
132	60.63a	63.91a
Mulch x K rate	ns	ns

Mean separation in columns by Duncan's multiple range test, 5% level.

ns Not significant

TABLE 2

Influence of K fertilizer rates and mulches on total number of fruits harvested, marketable fruit weight and average weight per fruit

Treatment	Total fruit no. (x 10 ³ ha ⁻¹)	Marketable fruits	
		Total (t ha ⁻¹)	Av.wt./fruit (g)
Mulch			
None	307.69d	3.22c	10.02a
Black plastic	620.90b	6.80b	10.79a
Reflective plastic	779.31a	8.92a	11.58a
Coconut fronds	484.05c	5.41b	10.95a
K (kg K ha ⁻¹)			
0	357.68c	3.44c	9.54a
66	562.73b	6.50b	11.48a
132	723.54a	8.33a	11.53a
Mulch x K rate	ns	ns	ns

Mean separation in columns by Duncan's multiple range test, 5% level.

ns Not significant

respectively. A similar effect for K rates was found for fruit number. The number of fruits was highest with highest K rate.

Mulch influenced soil temperature measured at 10 cm depth (Table 3). Under plastic mulch, soil temperatures were higher than coconut frond mulch and bare-ground. Soil temperature was lowest with coconut frond mulch. Without mulch, however, the soil temperature was also lower than normal ambient temperature.

The effect of mulch on soil moisture varied with materials used (Table 3). Without mulch, soil moisture was lower than with mulch. Soil moisture under coconut frond mulch was 13% and 7.5% higher than that

without mulch and reflective plastic mulch, respectively.

Mulch had significant effects on N, K and Ca contents in leaf tissues at both samplings (Table 4). With mulch, N and K contents were higher than those without mulch. However, their effect on Ca was indeterminate. At early fruiting, plants grown without mulch contained significantly higher Ca than those grown under coconut frond mulch. However, at the end of the experiment, plants grown under reflective plastic mulch had higher Ca content than those under other mulches. Phosphorus content was not affected by mulch.

At both samplings, K rates only influenced K content in leaf tissues (Table 4). Potassium content increased with increased K rates. Except for Ca, the nutrient content in general decreased as plants get older.

DISCUSSION

The increase in growth for mulched plants shows that mulching is practically beneficial in chilli production. Increased plant growth may be related to soil temperature and soil moisture content because plant dry weight was positively correlated with soil temperature ($r=0.64$) and moisture content ($r=0.71$). According to Bhella (1988) increased plant dry weight for mulched plants is due to the capabilities of mulch to maintain soil moisture as well as increased efficiency in water uptake by plants. Increase in soil temperature and moisture content stimulate root

TABLE 3

Influence of mulch on soil moisture content and soil temperature

Mulch	Soil moisture (%)	Soil temperature (°C)
None	24.47b	29.40c
Black plastic	26.48a	32.00a
Reflective plastic	26.34a	30.28b
Coconut fronds	27.24a	28.22d

Mean separation in columns by Duncan's multiple range test, 5% level. Average ambient temperature 31-32°C.

TABLE 4
Influence of K fertilizer rates and mulches on leaf nutrient content (%) at 2 samplings

Treatment	Early fruiting stage				End of experiment			
	N	P	K	Ca	N	P	K	Ca
Mulch								
None	3.92b	0.70a	3.85b	0.34a	2.43b	0.46b	2.10b	0.44b
Black plastic	4.14a	0.64a	4.29a	0.32a	2.82a	0.46a	2.53a	0.52b
Reflective plastic	4.09a	0.71a	4.10a	0.38a	2.73a	0.45a	2.68a	0.63a
Coconut fronds	4.04a	0.69a	4.09a	0.26b	2.56a	0.49a	2.40a	0.31b
K (kg ha ⁻¹)								
0	4.22a	0.67a	3.70b	0.37a	2.64a	0.50a	2.10b	0.57a
66	4.11a	0.70a	4.06a	0.32a	2.67a	0.44a	2.42a	0.57a
132	4.05a	0.69a	4.32a	0.31a	2.67a	0.44a	2.57a	0.53a
Mulch x K rate	ns	ns	ns	ns	ns	ns	ns	ns

Mean separation in column by Duncan's multiple range test, 5% level.

ns Not significant

growth which leads to greater plant growth (Jones *et al.*, 1977). Although soil temperature under coconut frond mulch was lower, the growth effect may be more related to soil moisture content.

Fruit yields depend on plant size. The relatively poor growth of unmulched plants yielded less fruits than mulched plants. Highest yield produced by plants grown under reflective plastic mulch may be due to the effects of reflected light from the mulch surface. Dennis *et al.* (1989) showed that aluminium film mulch reflects light which may be used in photosynthesis. Yield from plants grown under coconut frond mulch was less than the plastic mulch, but higher than those unmulched. Yield increase may be attributed to more favourable soil moisture and nutrient utilization (Chalfant *et al.*, 1977). In general, mulched plants had higher N and K contents than unmulched plants.

Growth and fruit yields were associated with K availability in the soil. Increasing K fertilizer rates applied increased growth and yield. Similar results were reported by Kadam *et al.* (1985). However, K rates had no influence on N, P and Ca contents in leaf tissues. Potassium content increased with increasing K rates indicating that the nutrient contents in the plants were affected by the amount of nutrients available in the growing medium. Although the effect was not

significant, Ca content apparently decreased with increased K rates. This was probably due to the antagonistic effect of both elements in plant uptake.

The results from this experiment suggest that K fertilizer rate at 132 kg K/ha with mulching is promising for yield increases in chilli production. Further investigation is recommended with other major plant nutrients to obtain maximum benefit from fertilizer applied and types of mulching under Malaysian environmental conditions.

REFERENCES

- BHELLA, H.S. 1988. Tomato response to trickle irrigation and black polythene mulch. *Journal American Society of Horticultural Science* **113**: 543-546.
- CHALFANT, R.B., C.A. JAWORSKI, A.W. JOHNSON and D.R. SUMNER. 1977. Reflective film mulches, millet barriers, and pesticides: Effects on watermelon mosaic virus, insects, nematodes, soil-borne fungi, and yield of yellow summer squash. *Journal American Society of Horticultural Science* **102**: 11-15.
- CLOUGH, G.H., S.J. LOCASCIO and S.M. OLSON. 1990. Yield of successively cropped polyethylene mulched vegetables as affected by irrigation methods and fertilization management. *Journal American Society of Horticultural Science* **115**: 884-887.

- DENNIS, R.D., J.K. MICHAEL and G.H. PATRICK. 1989. Mulch surface colour affects yield of freshmarket tomatoes. *Journal American Society of Horticultural Science* **114**: 216-219.
- JONES, T.L., U.S. JONES and D.O. EZELL. 1977. Effect of nitrogen and plastic mulch on properties of troup loomy sand and yield of 'Walter' tomatoes. *Journal American Society of Horticultural Science* **102**: 273-275.
- KADAM, P.X., D.P. BHORE, N.S. SHIRSOTH and D.A. RANA. 1985. Effect of different levels of potash on yield of chilli var. Jwala. Maharashtra *Journal of Agriculture Dune* **411**: 005 (*Hort. Abstr.* 55: 6933).
- LOCASCIO, S.J., J.G.A. FISKEL and R.D. HAUCK. 1985. Nitrogen accumulation by pepper as influenced by mulch and time of fertilizer application. *Journal American Society of Horticultural Science* **110**: 325-328.
- MITSUO, I. and Q.B. LE. 1978. Effects of mulching with black plastic film and rice straw on moisture and temperature in soil in Melon Delta. *Japanese Journal of Tropical Agriculture* **31**: 77-81.
- SCHALES, F.D. and R. SHELDRAKE. 1965. Mulch effects on conditions and muskmelon response. *Proceeding of American Horticultural Science* **188**: 425-480.
- SCHALK, J.M., C.S. CREIGATON, R.L. FERY, W.R. SITTERLY, B.W. DEWIS, T.L. MCFADDEN and AUGUSTINE DAY. 1979. Reflective film mulches influences insect control and yield in vegetables. *Journal American Society of Horticultural Science* **104**: 759-762.
- SHEARMAN, R.C, D.H. STEINEGGER, E.J. KINBACHER and T.P. RIORDAN. 1979. A comparison of turfgrass clippings, oat straw and alfalfa as mulching material. *Journal American Society of Horticultural Science* **104**: 461-463.
- VAN DERWERKEN, J.E. and L.D. WILCOX. 1988. Influence of plastic mulch and type and frequency of irrigation on growth and yield of bell pepper. *Horticultural Science* **23**: 985-988.
- WIEN, H.C. and P.L. MINOTTI. 1987. Growth, yield and nutrient uptake of chili as affected by plastic mulch and initial nitrogen rate. *Journal American Society of Horticultural Science* **112**: 759-763.

(Received 22 December 1993; accepted 6 September 1995)

ABSTRACT

Chilli (*Capiscum annuum* L.) was grown under different mulching treatments (black plastic, white plastic, rice straw, and no mulch) and potassium levels (0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 520, 540, 560, 580, 600, 620, 640, 660, 680, 700, 720, 740, 760, 780, 800, 820, 840, 860, 880, 900, 920, 940, 960, 980, 1000 kg/ha) in a randomized block design. The results showed that the highest yield of dry matter (DM) and fresh weight (FW) was obtained with black plastic mulch and 50 kg/ha potassium. The highest DM and FW were obtained with black plastic mulch and 50 kg/ha potassium. The highest DM and FW were obtained with black plastic mulch and 50 kg/ha potassium. The highest DM and FW were obtained with black plastic mulch and 50 kg/ha potassium.

INTRODUCTION

Yield of mungbean (legume) under dry conditions is generally low due to insufficient soil water and the lack of existing soil water. Mungbean growth duration is relatively short and the crop does not accumulate a good amount of nitrogen. Therefore, application of nitrogen fertilizer is essential for high productivity (Hassid et al. 1975). Through direct sowing of the mungbean plants (Shah et al. 1979, Gaur and Chahal, 1983), Epperson

also shows the major soil direct effects on vegetable growth and seed yield of legume (Shah and Bhat, 1979; Bhat et al. 1981; Herbert and Guggenma, 1983). Leaf area index (LAI) can increase decomposition of dry matter production and biomass yield (Bhat et al. 1981). However, studies on growth pattern and understanding the various physiological processes under variable plant population densities in relation to soil field of mungbean to enable