*Short Communications*

# INFLUENCE OF GREENHOUSE COVER MATERIAL ON LIGHT TRANSMISSION, APHIDS, MITES, POWDERY MILDEW AND ROSE PETAL COLOUR

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***Abstract***

*A research to investigate the influence of greenhouse cover material on insect pest infestation, powdery mildew and rose petal blackening was carried out in three commercial rose farms in Kenya. The farms are situated in Kericho, Eldoret and Juja. The research was carried in two phases: Field survey with most information being collected through structured questionnaire and on site tests. Rose petal blackening was not associated with any type of green house cover, but was dependent on the age of the cover material. The highest number (15.7 mites/plant) of mites was observed at the Juja flower farm, an area associated with high temperatures. Powdery mildew infection was significantly high in the three year old polyethylene covered greenhouses compared to the level of infestation in the greenhouses with new covers. The spectral transmission properties of greenhouse covering materials tested indicated that the amount of solar energy transmitted to the plant canopy is influenced by the position at which the radiation is taken. As the covering material ages, the percent petal blackening of roses as well as powdery mildew increases thus affecting the quality of flowers.*

**Key words**: rose petal lackening, spectral transmission, greenhouse temperature, aphids, mites, powdery mildew

## INTRODUCTION

Horticulture industry in Kenya is a vibrant sub-sector making it the second foreign exchange earner after tourism. The total export earnings from horticulture in the year 2007 amounted to Ksh 65.2 billion (MOA, 2008) out of which cut flowers accounted for Ksh 29.7 billion. In 2008, the sector exported 423.1 million kg that earned 73.7 billion out of which flowers accounted for Ksh 39.9 billion. The production of cut flowers continued to increase with a corresponding area under the crop marginally rising from 3 026 ha in 2006 to 3 063 ha in 2007 (MOA, 2008). Floriculture is the most successful sector of horticulture contributing more than 12% of Kenya's foreign exchange earnings

Apart from earning the economy the much-needed foreign exchange, production of the crop offers huge employment opportunities. In Kenya, the majority of rose production is under greenhouse. In the international market, rose producers face tough competition. Produce quality is the most important factor affecting rose marketing. Uniform and fashionable flower colour is the requirement for entering the international market and to fetch good price.

Rose petal colour is determined by the genetic characteristics of the cultivar while shifts with the variation of the environment in which it is produced. This is a widely accepted concept but the exact relationship between rose petal colour development and environmental variation has not been established. In the flower industry, some farms get excellent colours because of the conducive greenhouse environment. However, in most cases, non-uniformity of flower colour affects the marketing of roses. In severe cases, petal blackening results in roses fetching very low prices or even rejection from the international market.

Being the main export cut flower from Kenya, maintaining the quality of rose will ensure its competitiveness in the international market. Currently, colour variation of rose petals has been of a great concern to large-scale producers of roses in Kenya. Most farms have reported considerable losses associated with rose petal blackening (RPB). Some researches found that UV light and low temperature are the main causes (Raviv, 1989). However, this has not led to successful control of the problem, and it implies that some other environmental factors are also involved. In fact, petal blackening is just one type of colour variation caused by environment.

Colour variation happens to varieties of different colours and in different directions, some become dark and some become light. Two major groups of pigments associated with petal blackening are produced in the petals: carotenoids and anthocyanins. Carotenoids contribute to the orange in flower colouring, while anthocyanins play a great role in flower colour variation. Anthocyanins also bond with other chemicals to form copigments and leads to the creation of purple to blue colour because of the hyperchromic effect and bathochromic shift (Yu and Zhang, 2002). The common chemicals bonding with anthocyanins include flavonoids, polyphenols, alkaloids, amino acids, and some organic acids (Hoshino et al., 1981; Mazza and Miniati, 1993). As in the case of a blue rose cultivar, the bluing of petals was because of the copigment formed by cyaniding-3.5-diglycoside and gallic acid (Brouillard, 1983). Anthocyanins also chelates metal ions and leads to a blue to purple flower colour (Kondo et al., 1992).

The research aimed at ascertaining the relationship between greenhouse covers, light transmission petal blackening as well as insect pest population and powdery mildew in selected commercial rose plant farms.

## MATERIALS AND METHODS

Field surveys concentrated in farms in Kericho, Eldoret and Juja areas of Kenya as the farms were using similar covering materials mainly: UV205, IR504 and Nectarine. The effect of the type and age of these polyfilms on light transmission, powdery mildew, aphids and mites on roses was studied in the three farms. Twenty plants (4 plants were randomly selected in five different positions within the greenhouse) at each position (center and edges) of every greenhouse were used for colour development and pest population monitoring.

The colour development as well as pest and disease monitoring was carried out on the most affected (red) cultivars, where the covering material was matched with the pest, diseases and petal blackening.

Initial data on most of the required parameters, including; the age and type of the covering material effects on common pests was collected through the use of a questionnaire. Light transmission was measured at the research sites. In the data arrangement, research site (location) was taken as the independent variable, age and type of the covering material depended on the location, while pests and diseases depended on both the location and the type of the covering material being used.

The sampled plants in every location in the greenhouse were carefully analyzed for number of aphids and mites per plant, scored for powdery mildew and petal blackening.

The spectral transmission properties of greenhouse covering materials was tested by using photospectra meter (UV, visible light, and infrared light) with a photospectra meter (SP752, SHANGHAI 3RD ANALYTIC INSTRUMENT CO.) The average daily PAR transmission for cover materials was analyzed from the polyethylene cover materials gotten from all the three sites of research employing the methods suggested by Ting and Giacomelli (1987b) and Giacomelli, et al., (1988). The observations were made at:

(1) 0.5 m below the covering material (at roof), which represented transmission of the covering material alone, and
(2) 1.8 m above the ground (at plant canopy), which represented the influence of the greenhouse structure and the covering material on transmission.

## RESULTS AND DISCUSSION

### Polyethylene covers, insect and powdery mildew effects

Pest infestations were mainly attributed to the mites and aphids. Of the three sites, Juja flower farm had the highest number of mites per plant (Figure 1) and the largest percent of powdery mildew compared to the other two sites (Figure 2). The increase in powdery mildew with the aging of the covering material could be attributed to the fact that the sporulation of some fungi depends on the UV light. Aphid infestation was independent of the location, while age of the covering material did not significantly ($p \leq 0.5$) affect the population of either the aphids or mites.

**Figure 1:** Mite and Aphid distribution as affected by the location of the flower farms

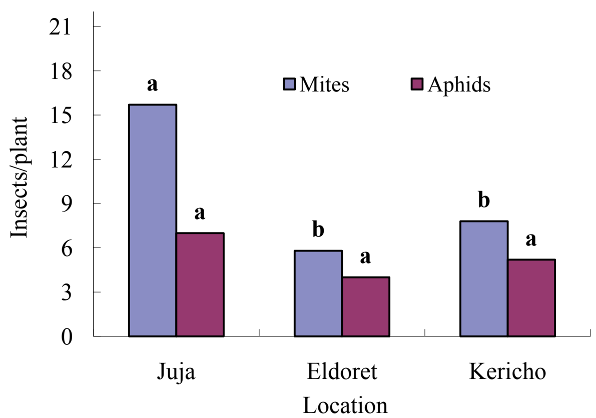
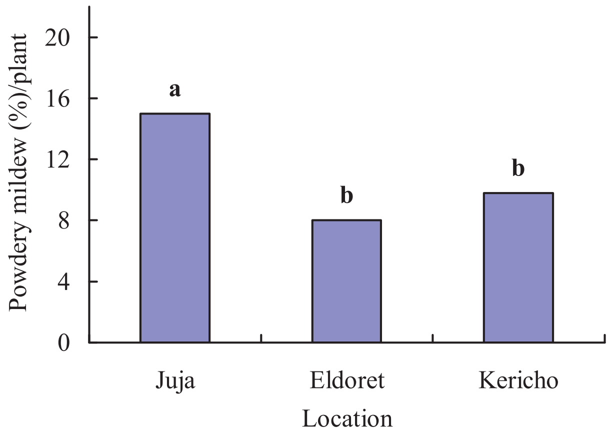


**Figure 2:** Powdery mildew infection rate as affected by location




## Polyethylene covers and petal blackening

Of the three locations, the highest percentage of roses with petal blackening was observed at the Eldoret flower farm, however, this was not statistically different from the two other sites. The highest rose petal blackening of 4.7% was observed in the 2nd year covering material (Figure 3). It is possible that the wavelength of light being radiated through the two year old polyethylene covers was causing more petal pigmentation linked to the process of cell expansion (Martin and Gerats, 1993).

The three different types of covering materials tested responded differently to the occurrence of petal blackening. Greenhouses covered with Nectarine polyfilms had the highest incidences of petal blackening of 12% compared to those covered either with either UV 205 or IR 04 (Figure 4). On the other hand, rose plants produced under older polifilms were attacked more ($R^2 = 96\%$) by powdery mildew across all the sites than those produced in green house with new covers (Figure 5).

**Figure 3:** Effects of age of green house covering material on petal blackening (%) of Rose flowers

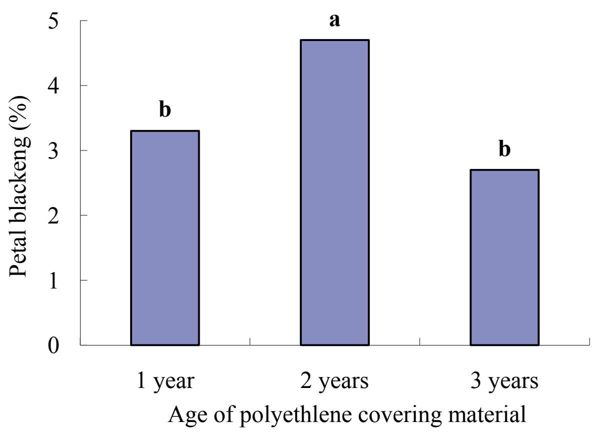



**Figure 4:** Interactive effects of type and age of covering material of Petal Blackening on roses

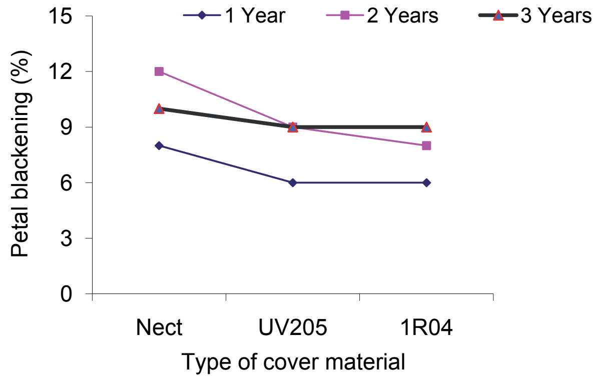
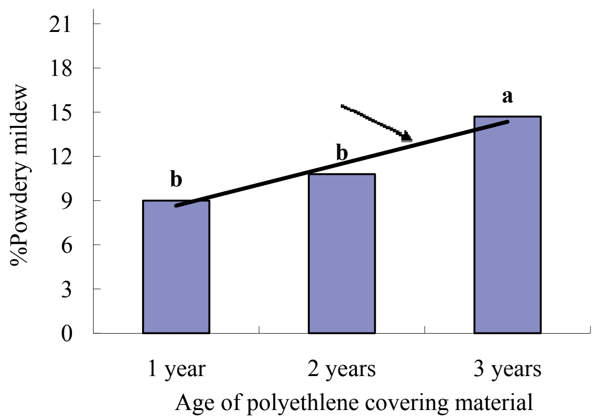



**Figure 5:** Incidences of powdery mildew as influenced by age of polyethylene covering material




## Light and rose petal colours

The results indicated that the amount of solar energy transmitted to the plant canopy is influenced by the position at which the radiation is taken (Table 1). These results confirm that factors other than the type of cover material could significantly affect the percentage of available solar radiation which is transmitted to the plant canopy. Radiation heat losses are directly related to the physical properties of the cover material. These include the emissivity and the transmissivity (in the infrared and thermal wavebands) of the covering material. The emissivity is a material property which defines its ability to emit radiation energy that it has absorbed. In this research, the rate of light transmission was not significantly ($p \leq 0.05$) affected by the age of the covering material (Table 2). All films lose light transmission capabilities over time. There was a reduction of between 9.5% and 11.1% reduction in transmission measured at the roof and that taken at the canopy of rose plants, this compares well with 6.8% reduction reported by Giacomelli et al. (1988) on tests

**Tab. 1:** Average Daily Percent Transmission of PAR (400–700 nm) measured just inside the roof and near the plant canopy inside the greenhouses

| Position from roof | Average Percent Transmission | | |
|---|---|---|---|
| | Eldore farm | Juja farm | Kericho farm |
| 0.5 cm | | | |
| | 60.4 | 59.3 | 68.6 |
| | 55.8 | 57.4 | 66.8 |
| | 66.2 | 58.3 | 67.7 |
| 1.8 cm (plant canopy) | 56.4 | 56.1 | 45.1 |
| | 54.6 | 55.9 | 44.6 |
| | 57.3 | 57.3 | 46.1 |

**Tab. 2:** Effects of cover material age on percent transmission of PAR measured at 0.5 m above the roof in polyethylene covered greenhouses

| | Transmission | | | | | |
|---|---|---|---|---|---|---|
| | 0–6 months | | | after 30 48 months | | |
| Waveband | Eldoret | Juja | Kericho | Eldoret | Juja | Kericho |
| 400–700 nm | 0.73 | 0.68 | 0.72 | 0.68 | 0.69 | 0.65 |
| 300–1100 nm | 0.75 | 0.64 | 0.78 | 0.72 | 0.59 | 0.71 |

carried out on four year exposure polyethylene films. The author attributed the degradation of the physical properties of the cover material to dust, dirt and air pollutant accumulation. Other factors that have been associated with deterioration include ultra violet radiation that has been thought to promote photochemical degradation processes in all plastics. Temperature extremes and their duration can also weaken the film. This can typically become a problem where the film contacts the greenhouse structure. Internal sources such as chemicals used for pest control, which can also cause premature failure of the plastic.

Polyethylene covers used over a period of three years will increase the rate of occurrence of rose colour changes, increase light transmissivity and occurrence of powdery mildew. It therefore appears that the best option to manage rose colours and avoid petal blackening is therefore to use the right type of polyethylene covers that include IR04 and UV205 changed at regular intervals.

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