Effects of Storage Condition and CIPC Treatments on Sprouting and Weight Loss of Stored Yam Tubers

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ABSTRACT

Yam is an important staple food in West Africa, it is an annual crop; thus there is the need for the tuber to be stored for a period of 5 – 7 months to make it available all year round. The major problems in yam tuber storage are sprouting, respiration and transpiration, which causes weight and quality losses. In this work, two storage conditions and two different pre-storage treatments in yam storage were evaluated. The storage conditions were two traditional yam barns; with a fan placed in one of them to aid air flow, with no fan in the other. The pre-storage treatments used were; Chloro Isopropyl Phenyl Carbamate (CIPC) solution in four levels and CIPC powder in four levels. A total of 84 tubers of yam, *"Giwa"* variety *(Dioscorea roundata)* were stored in each barn for six months. Parameters evaluated were temperature, relative humidity, weight loss, rate of sprouting and rot development. The results showed that the temperature in barn with forced air circulation fluctuated between 20.5 and 36^{0}C with an average of 30^{0}C while that in the barn without forced air circulation fluctuated between 23 and 39^{0}C with an average of 32^{0}C over the six months period of the experiments. The relative humidity in the barn with forced air circulation ranged between 25 and 60% with an average of 43%, while that in the barn without forced air circulation ranged between 28 and 61% with an average of 46% over the same period. The tubers in the barn with forced air circulation showed less sprout weights and less weight loss than those stored in the barn without forced air circulation throughout the period of storage. At the end of a 3-month period, the tubers in the ventilated barn showed 4.7% less weight loss than comparable tubers receiving no controlled air flow. The CIPC chemicals (powder and solution) at all levels did not have any effect in suppressing sprouting in *dioscorea rotundata, n*either did they show visible effect on rot in the stored yam tubers. However the barn with forced air circulation had 1.85% rottened tubers while 12.05% tubers in the barn without forced air circulation were rotten.

INTRODUCTION

Yams (*Dioscorea spp.)* are the most important food crops in West Africa, next to cereals, (Onwueme, 1978). The white yam originates in West Africa, It is the most important variety of yam cultivated for human nutrition, not only in this region but throughout the world. (Onwueme, 1978) Not only is yam an important staple food, yam is considered a man's crop and has ritual and socio-cultural significance. Before the introduction of cereals and grains, also, important staple foods in West Africa, yams were the major source of carbohydrate (Coursey, 1976).

The storage life of the tuber is ended at the termination of dormancy, when new sprouts develop. Good storage should therefore maintain tubers in their most edible and marketable condition by preventing large moisture losses, spoilage by pathogens, attack by insects and animals, and sprout growth.
However, in other to obtain a good result after storage (i.e. fresh, edible and marketable yams), the freshly harvested yams to be stored must be clean and undamaged. Also, excessive temperature must be avoided and good aeration provided. Causes of storage losses of yam tubers include: Sprouting, transpiration, respiration, rot due to mould and bacteriosis, insects/Mammals/nematodes (Osagie, 1992).

Methods of storage vary from delayed harvesting or storage in simple piles or clamps to storage in buildings, specially designed for the purpose, and application of sophisticated modern techniques.(Osagie, 1991). Also, Igbeka (1985), Nwakiti and Makurdi (1989) adequately described yam storage practices.

Oyeniran and Adesuyi (1983) reported that Chloro Isopropyl Phenyl Carbamate suppressed sprouting in *D.alata* tubers for about three months. Chloro Isopropyl Phenyl Carbamate chemicals are also being used in successful storage of potatoes. In his study, Mozie (1983) reported that there was significant difference in the percentage sprouting rate and the rate of weight loss of yam tubers stored in the conventional barn when supplied with airflow intermittently, continuously or non at all (i.e no airflow). He observed that intermittent airflow allowed significant less weight loss than continuous airflow and no airflow; also, that intermittent airflow caused significant less sprouting than continuous airflow and no airflow.

This study is aimed at investigating and evaluating the effect of intermittent forced airflow and sprout suppressing chemicals (CIPC solution and Powder) on sprouting and weight loss of stored yam tubers.

METHODOLOGY

The experiment was carried out at Minna, Niger State; which is located on the Guinea Savannah Ecological zone. Two traditional yam barns were used for this experiment; they were erected in the open air, where sufficient shade and ventilation was available. The frame of the yam barn consisted of vertically erected wooden poles of 2m in height and set at a distance of 1m to each other, these wooden poles were stabilized by attaching horizontal poles to them. The dimensions for each barn was; width: 2.5m, length: 3.5m, height: 2m. Locally knitted thatch (made of dried plant stalks) were wound round the frame and on top, this served as the roof and the wall. There was a slight opening between the roof and wall to allow for optimum ventilation and reduction in ambient temperature inside the barn.

Two of such structures were built and a standing fan to aid airflow was placed in one of them. The fan, with a blade diameter of 40cm and airflow rate of $0.86m^3$/ second was allowed to supply air at 2 hourly intervals throughout the experiment period (8 – 10am, 12 – 2pm, 4 – 6pm, 8 – 10pm) while in the second barn, airflow was natural not forced. The "medium" fan speed with 27.24m/s speed was used for providing the forced intermittent airflow. The *"giwa"* variety was used for this experiment. A total of 84 yam tubers were stored in each barn, this were further sub-divided into seven sub-groups of 12 tubers each. The initial weights of the tubers were measured and recorded based on treatments used and levels, as the case may be. The tubers were arranged on wooden platforms, which were placed on the floor of the barns to reduce bruising and to facilitate airflow, weighing and making observations. The top loading weighing balance with 1g accuracy and 5kg capacity was used to weigh the tubers. Percentage weight loss was determined based on the initial tuber weight while rate of sprouting was determined by weighing the sprouts of the yam tubers.

The experimental design for this work involves two independent experiments, the design for each experiment is the complete block design with two factors as given by Gomez and Gomez (1983). The statistical analysis was carried out using Minitab statistical software package. The two storage conditions and two different pre – storage treatments evaluated were

Storage conditions:
Traditional barn with forced air circulation
Traditional barn without forced air circulation

Pre – storage treatments:
Chloro Isopropyl phenyl Carbamate (CIPC) solution in 4 levels
Chloro Isopropyl phenyl Carbamate (CIPC) powder in 4 levels

Parameters evaluated are:
Environmental parameters: Temperature and Relative humidity
Physiological parameters: Sprouting (De–sprouting was carried out manually, this was done bi monthly and the sprouts weighed),
Weight loss (Tubers were weighed before storage and at monthly intervals throughout storage period) and Rotting (observed and recorded once a month)

RESULTS AND DISCUSSIONS

Environmental Parameters

Temperature

Temperature in the barn with fan fluctuated between 20.5 and 36^{0}C with an average of 30^{0}C, while that in the barn without fan fluctuated between 23 and 39^{0}C with an average of 32^{0}C over the 6 Months storage period. (Fig 1).

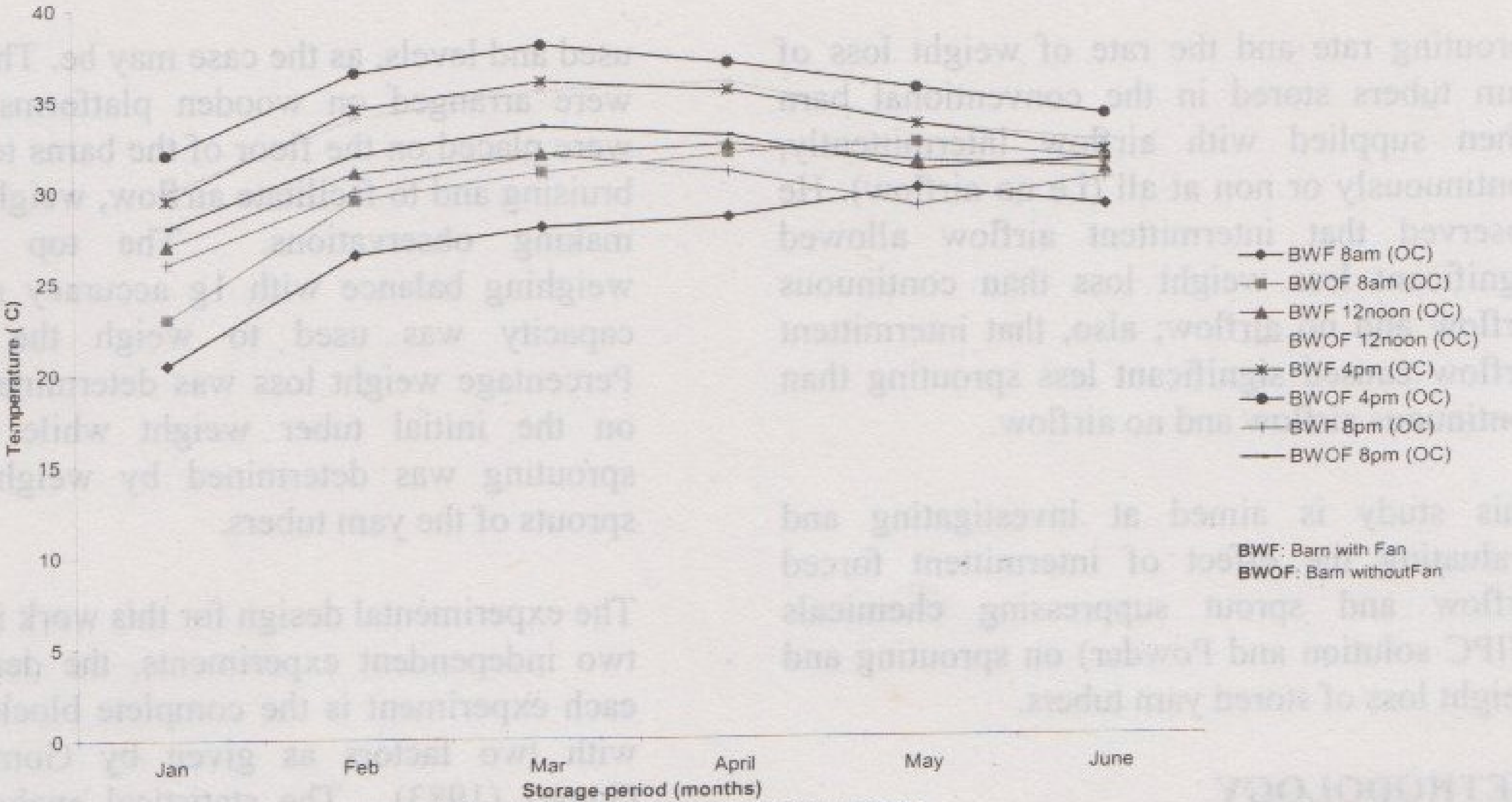

Figure 1 : Monthly average temperature in the two barns

Figure 1 shows that the barn without fan had the highest temperature (38^{0}C) at 4pm while the barn with fan had a temperature of 36^{0}C at the same period. The barn with fan also had the lowest temperature (20.5^{0}C) at 8am while that of barn without fan was 23^{0}C during the same period. The little difference in temperature between the two barns may be attributed to the presence of fan, which helped to improve airflow and this may have led to the slight decrease observed in the temperature inside the barn as compared to the barn without fan.

Relative Humidity.

Relative humidity in the barn with fan ranged between 28 and 61% with an average of 46% while that in the barn without fan ranged between 25 and 60% with an average of 43% (Fig 2). The average humidity in the barn with fan was 3% higher than that in the barn without fan, this may be attributed to the slightly lower temperature experienced in the barn with fan as compared with the barn without fan; Gerardin, *et al* (1998), Osunde and Yisa, (2000) recorded a similar observation but their work was on the improved barn and pit structures.

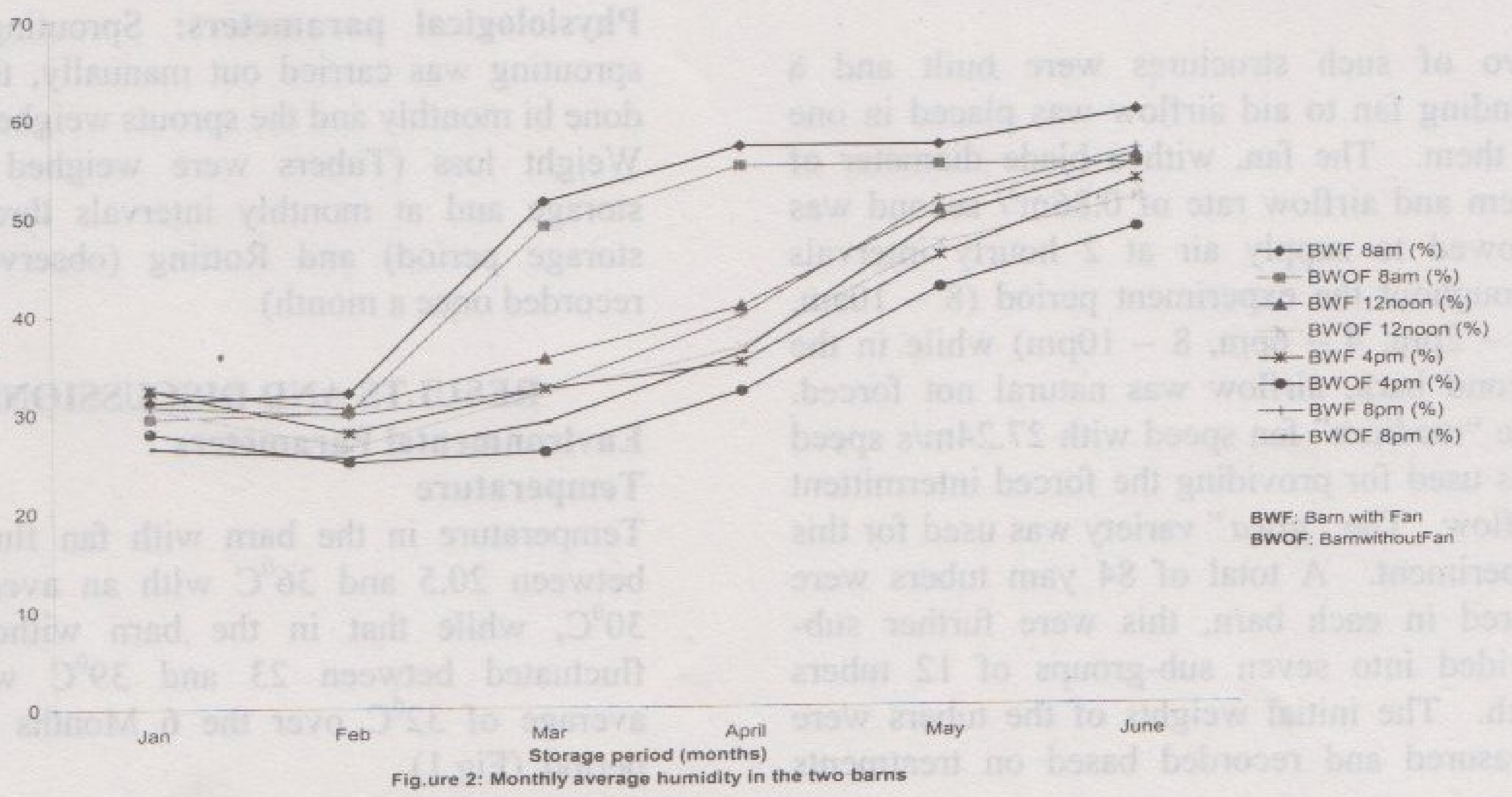

Fig.ure 2: Monthly average humidity in the two barns

Physiological Parameters

Sprouting.

Figure. 3 shows that tubers stored in the barn with fan showed less sprout weights than those stored in the barns without fan. This could be due to the high rate of ventilation obtained in the barn with fan. This agrees with the findings of Mozie (1983); who reported that high rate of ventilation reduces the growth rate of vines in stored tubers.

Weight Loss
Figure 4 shows the percentage weight loss of tubers stored in the two barns. It shows that the barn with fan had the least weight loss through out the period of storage. The reduction observed in weight loss could be due to the fact that; as reported earlier, the barn without fan had the highest rate of sprout weights as compared with barn with fan; this could be responsible for the high weight loss since sprouting is one of the factors responsible for weight loss observed in the barn without fan. Also, the little difference in temperature and humidity between both barns may have slowed down the rate of weight loss in barn with fan. Although, Gerardin *et al.* (1998b) reported that to achieve a significant reduction in weight loss, the storage temperature needs to be reduced to between 15 – 20^{0}C.

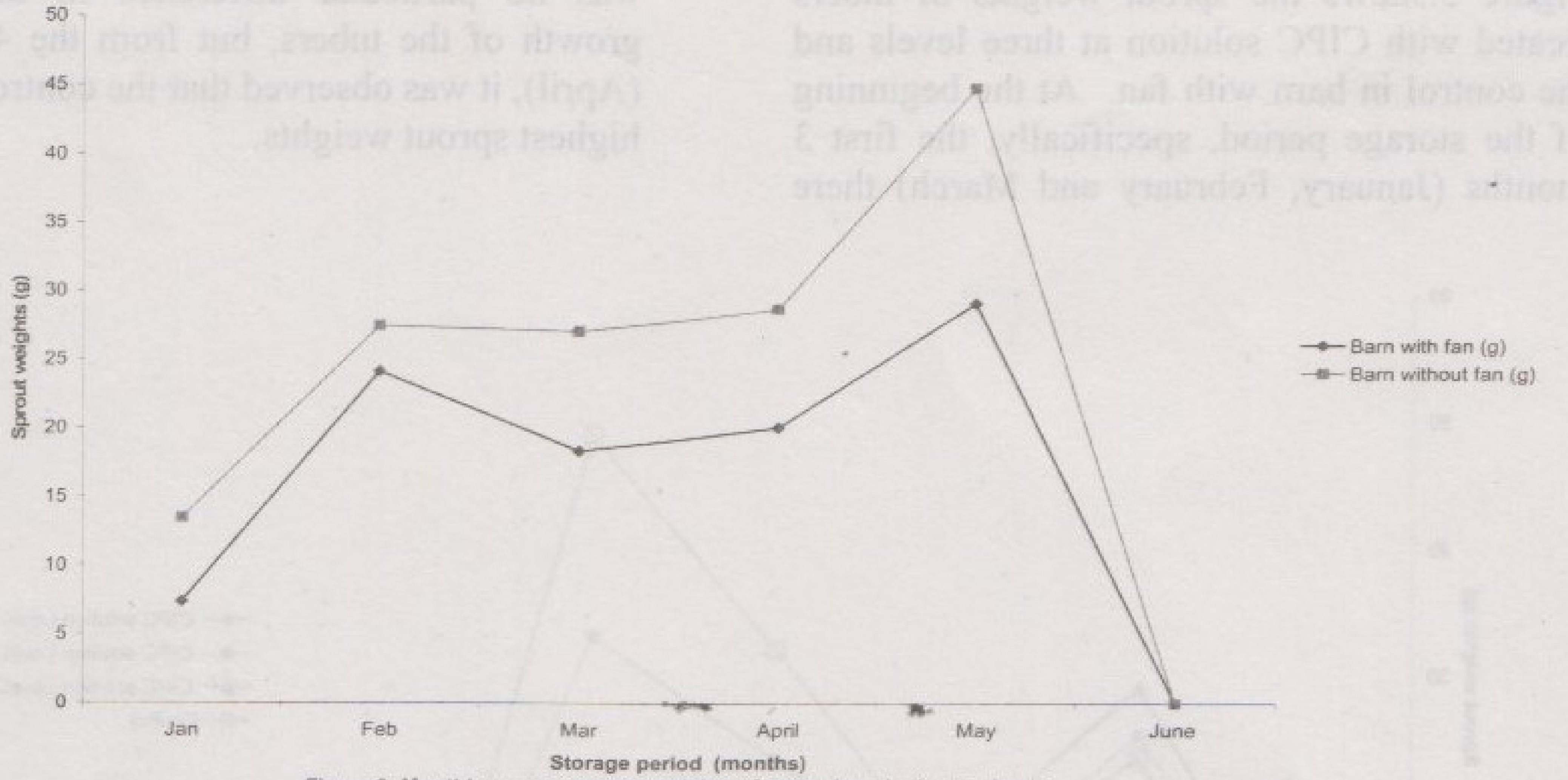

Figure 3: Monthly average sprout weights of yam tubers in the two barns

At the end of a 3 – month period, the tubers in the ventilated barn showed 4.7% less weight loss than comparable tubers receiving no controlled air flow under identical conditions of temperature and relative humidity (Fig. 4). The tubers receiving no controlled air flow continued to lose weight rapidly throughout the entire storage period than those stored under controlled air flow. Adesuyi, (1979) also confirmed that low temperature and high humidity during storage period slows down the rate of weight loss.

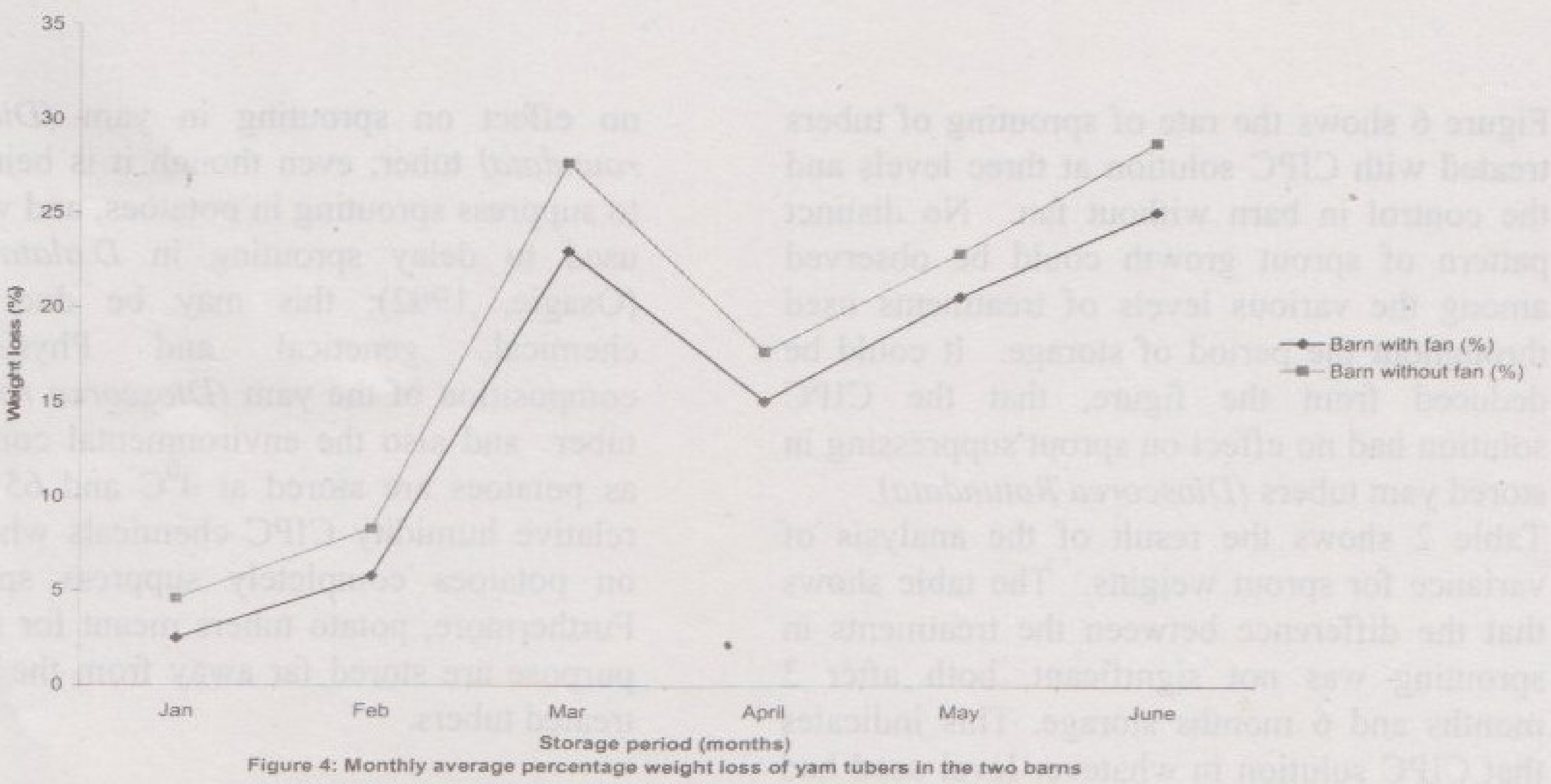

Figure 4: Monthly average percentage weight loss of yam tubers in the two barns

Table 1. Indicates that the effect of structure on sprouting is significant at 5% level in May; also, the ANOVA table indicates that the effect of structure on weight loss is significant at 5% level in February, March and June.

Table 1: Significance of Differences in Sprouting and Weight Loss between the Two Barns.

Months	Jan	Feb	March	April	May	June
Sprouting	Ns	Ns	Ns	Ns	*	-
Weight loss	Ns	*	*	Ns	Ns	*

Significant at 5% level

Ns: not significant.

Figure 5.shows the sprout weights of tubers treated with CIPC solution at three levels and the control in barn with fan. At the beginning of the storage period, specifically, the first 3 months (January, February and March) there was no particular difference in the sprout growth of the tubers, but from the 4th month (April), it was observed that the control had the highest sprout weights.

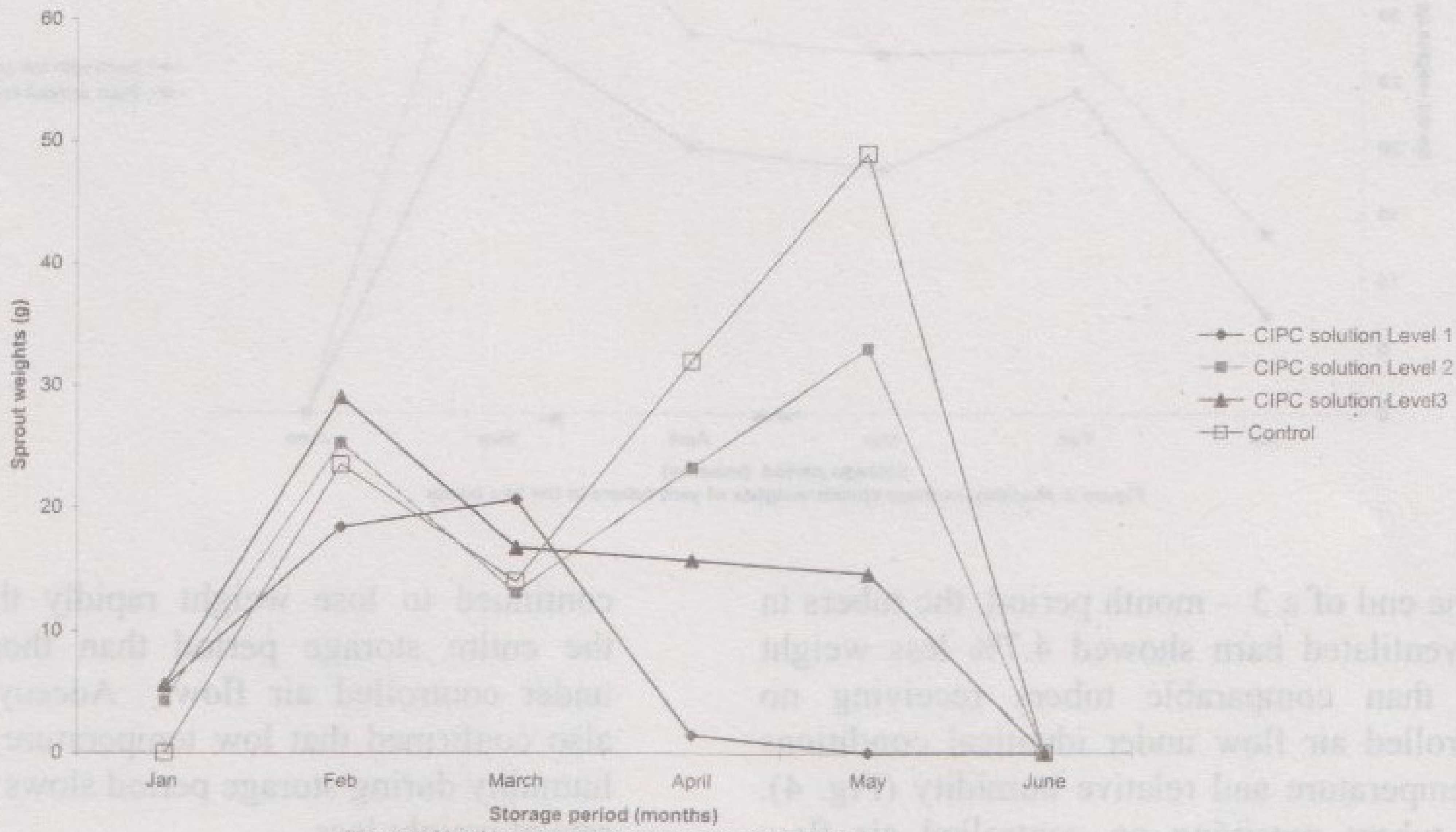

Figure 5: Monthly average sprout weights of yam tubers treated with CIPC solution and control (barn with fan)

Figure 6 shows the rate of sprouting of tubers treated with CIPC solution at three levels and the control in barn without fan. No distinct pattern of sprout growth could be observed among the various levels of treatments used throughout the period of storage. It could be deduced from the figure, that the CIPC solution had no effect on sprout suppressing in stored yam tubers *(Dioscorea Rotundata)*.

Table 2 shows the result of the analysis of variance for sprout weights. The table shows that the difference between the treatments in sprouting was not significant, both after 3 months and 6 months storage. This indicates that CIPC solution in whatever level used had no effect on sprouting in yam *(Dioscorea roundata)* tuber; even though it is being used to suppress sprouting in potatoes, and was also used to delay sprouting in *D.alata* tubers (Osagie, 1992); this may be due to the chemical, genetical and Physiological composition of the yam *(Dioscorea roundata)* tuber and also the environmental conditions, as potatoes are stored at 4^0C and 65 – 75% relative humidity CIPC chemicals when used on potatoes completely suppress sprouting. Furthermore, potato tubers meant for seedling purpose are stored far away from the CIPC – treated tubers.

Table 2: Significance of Differences in Sprouting between CIPC Solution and Structure.

Sprout weights (g)		
Period	3 months	6 months
Structure	n s	*
Treatment	n s	n s
Interaction	n s	n s

* Significant at 5% level
n s : not significant.

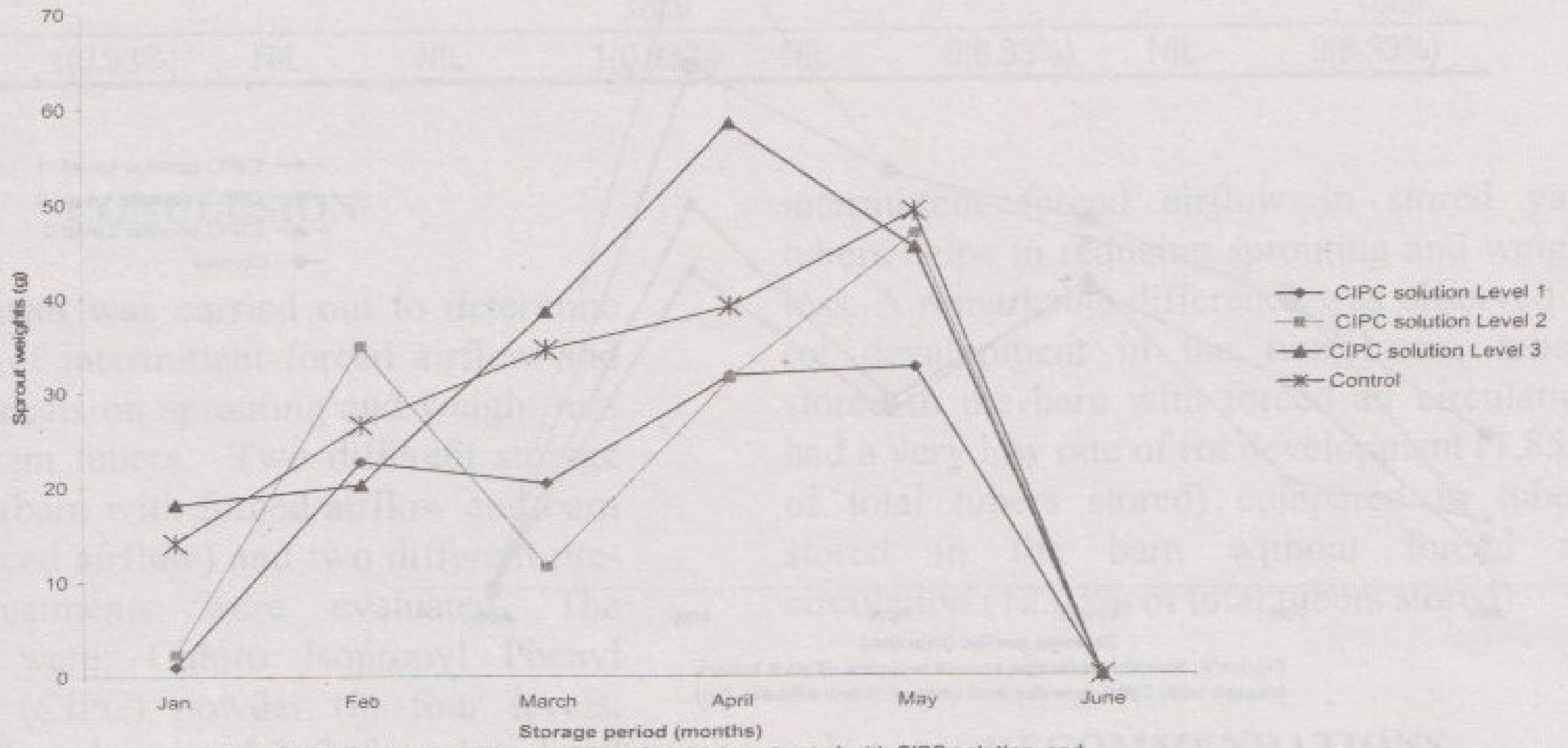

Figure 6: Monthly average sprout weights of yam tubers treated with CIPC solution and control (barn without fan)

Figure 7 shows the sprout weights of tubers treated with CIPC powder at three levels and the control in barn with fan. At the first and second months of storage (January and February) there was no remarkable difference in the sprout weights of the tubers irrespective of levels of treatments. However, by March, the CIPC powder (level 3) – treated tubers had the highest sprout weight while the control had the lowest at that particular time. In May the control had the highest sprout weight while the CIPC powder (level 1) – treated tubers had the lowest sprout weight.

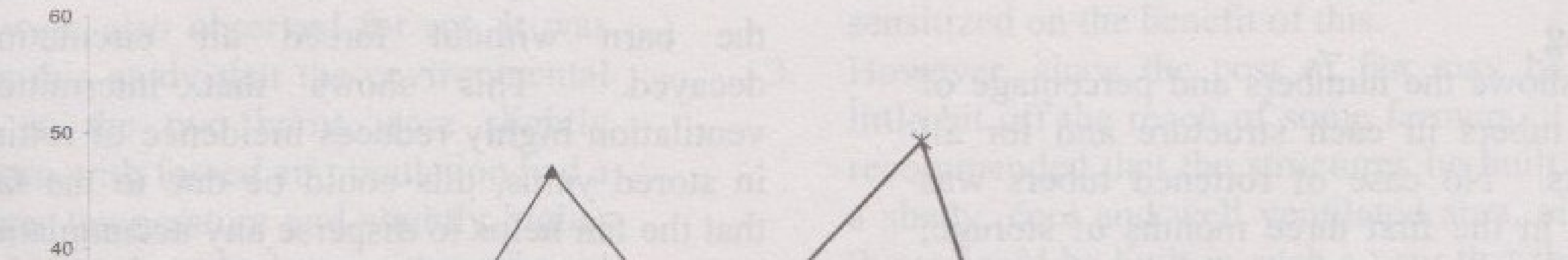

Figure 7: Monthly average sprout weights of yam tubers treated with CIPC powder and control (barn with fan)

Figure 8 shows the sprout weights of tubers treated with CIPC powder at three levels and the control in barn without fan. From the figure, CIPC powder (Levels 1 and 3) showed low sprout weight throughout the storage period while CIPC powder (level 2) and the control had the highest level of sprout weights. However, these differences were not statistically significant at both 3 months and 6 months as shown on Table 3. This further shows that the CIPC (Chloro Isopropyl Phenyl Carbonate) chemical either in solution or powder form had no effect on sprouting in stored yam (*Dioscorea rotundata*) tuber.

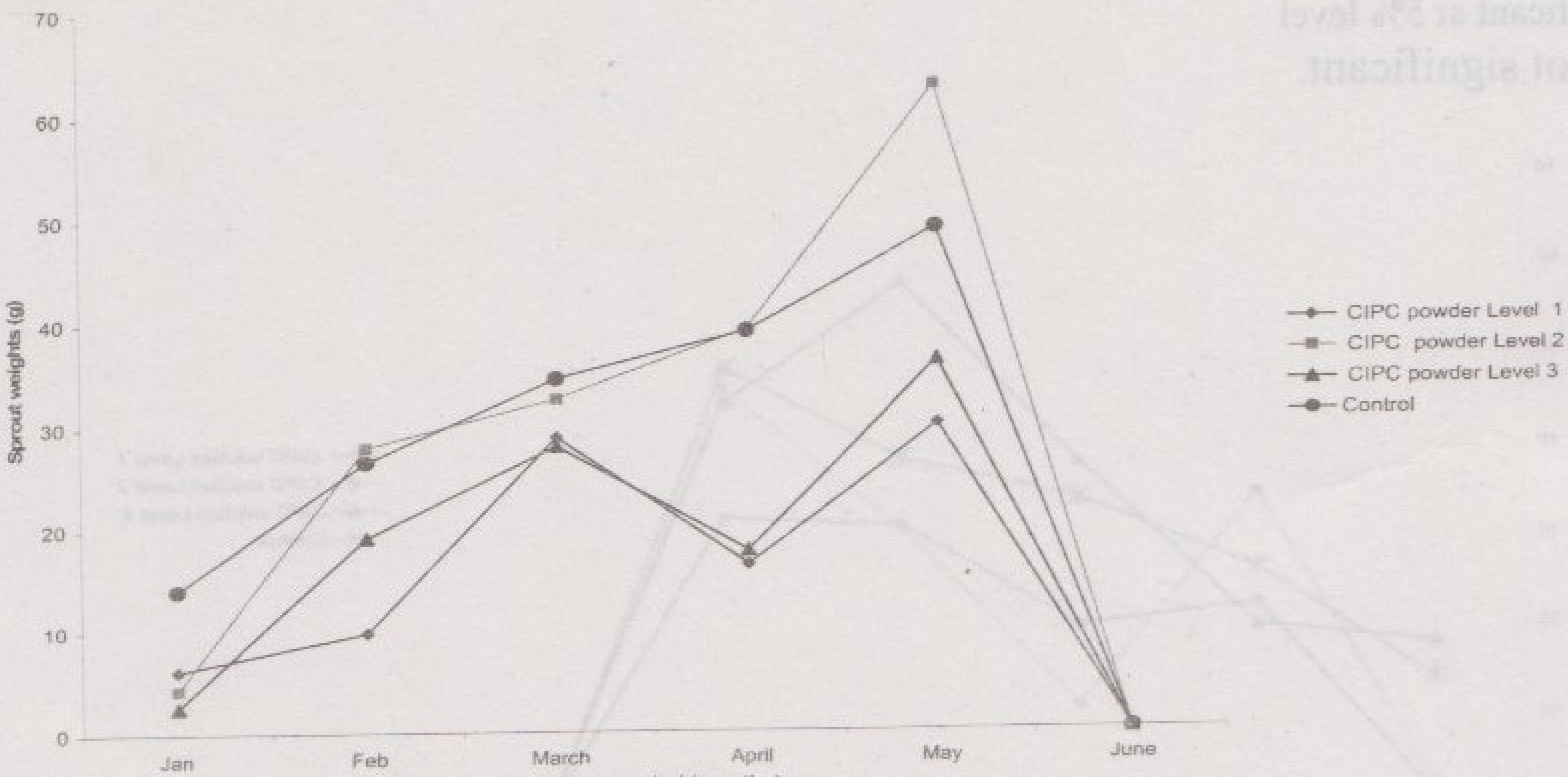

Figure 8: Monthly average sprout weights of yam tubers treated with CIPC powder and control (barn without fan)

Table 3: Significance of Differences in Sprouting between CIPC Powder and Structure.

Sprout weights (g)		
Periods	3 months	6 months
Structure	n s	*
Treatment	n s	n s
Interaction	n s	n s

* Significant at 5% level
n s: not significant.

Rottening

Table 4 shows the numbers and percentage of rottened tubers in each structure and for all treatments. No case of rottened tubers was observed in the first three months of storage; this is in agreement with Akinnusi *et al.* (1984).

It was also observed that the barn with forced air circulation had a low rate of rottened tubers, compared with the barn without forced air circulation i.e only 2 tubers (1.85%) out of the total tubers stored in the barn with forced air circulation, decayed; while a total of 13 tubers (about 12%) out of total tubers stored in the barn without forced air circulation, decayed. This shows that intermittent ventilation highly reduces incidence of rotting in stored yams, this could be due to the fact that the fan helps to disperse any accumulation of heat on or around the tubers which if allowed to remain could result in the rottening of the tubers in question.

The CIPC chemicals (solution and powder) are sprout suppressants, thus they may not have been able to suppress rot development; as indicated on the table, the CIPC powder – treated tubers had the highest number of rottened tubers.

Table 4 Effects of Storage Conditions and Treatments on Rotting

	Barn with Fan.				Barn without Fan.			
Months	CIPC solution	CIPC powder	Control	Grand Total	CIPC solution	CIPC Powder	Control	Grand Total
Jan.	-	-	-	-	-	-	-	-
Feb.	-	-	-	-	-	-	-	-
March.	-	-	-	-	-	-	-	-
April	-	-	-	-	-	1	-	-
May	-	-	-	-	-	-	-	-
June	1	-	-		-	8	-	
Total	1(0.93%)	NIL	NIL	1(0.93%)	NIL	9(8.33%)	NIL	9(8.33%)

CONCLUSION

An experiment was carried out to determine the effects of intermittent forced airflow and CIPC chemicals on sprouting and weight loss of stored yam tubers. Two different storage conditions (barn with forced airflow and barn without forced airflow) and two different pre-storage treatments were evaluated. The treatments were; Chloro Isopropyl Phenyl Carbamate (CIPC) powder (in four levels, level 1: 1g/kg tuber, level 2: 2g/kg tuber, level 3: 3g/kg tuber and control) and CIPC solution (in four levels, level 1:1.5ml/kg tuber, level 2: 3ml/kg tuber, level 3: 4.5ml/kg tuber and control).

Temperature and relative humidity in the two barns were measured four times a day, three times a week. Sprout removal was carried out twice a month and the sprout weights measured, the tubers were weighed once every month to determine weight loss of the tubers; the tubers were also observed for rot. It was observed in this study that the environmental parameters in the two barns were slightly different; barn with forced air circulation had a slightly lower temperature and slightly higher relative humidity than the barn without forced air circulation. The temperature in the barn with forced air circulation was 2^0C less than that of the barn without forced air circulation while the relative humidity of the barn with forced air circulation was 3% higher than that of the barn without forced air circulation.

The results showed that CIPC chemicals (solution and powder) which are used successfully to suppress sprouting in stored potatoes did not have any effect on suppressing sprouting in *D. rotundata* tubers. Low rate of sprouting and weight loss was observed in the barn with fan. This shows that intermittent forced airflow in stored yam tubers helps in reducing sprouting and weight loss. A remarkable difference was observed in rot development in the two barns, tubers stored in the barn with forced air circulation had a very low rate of rot development (1.85% of total tubers stored) compared to tubers stored in the barn without forced air circulation (12.03% of total tubers stored).

RECOMMENDATIONS

1. The use of Chloro Isopropyl Phenyl Carbamate (CIPC) chemical in combination with low temperature and high relative humidity as used in the successful storage of potatoes; need to be further investigated for use in the storage of other varieties of yam tubers.
2. Intermittent forced air flow has a positive effect in reducing sprouting, weight loss and rot development. Therefore, where power supply is available, farmers should be sensitized on the benefit of this.
3. However, since the cost of fan may be a little bit off the reach of some farmers, it is recommended that the structures be built in a shady, cool and well ventilated area, also they should be built in such a way that they are well aerated and away from heat. Other means of aiding the circulation of air flow should be looked into.
4. Also, further work may be carried out to find out the effect of different rates of air flow on the quality of stored yam tubers.

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