CIRAD RESEARCH AND PRACTICAL USE OF GROWTH REGULATORS IN AFRICA

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This is the first time that CIRAD takes part in this working group, and I'd like to take this opportunity to present you the main CIRAD research results on growth regulators in Africa. By Africa, I mean french speaking countries in the south of Sahara. And by CIRAD, I mean CIRAD in cooperation with national agronomic research Institutes.

In these countries cotton is grown by small farmers and harvested by hand at the beginning of dry season, with no problems of cold temperatures. So defoliants, dessicants or boll openers are not necessary. That is why we have worked only on growth regulants, mainly on Pix.

I hope exchange of experience on Pix between Europe, Middle -East and Africa will be of interest for all of us, because cotton responses in such different conditions should lead to a better global comprehension of Pix action and should finally result in recommendations for improved crop management practices by farmers.

In the first section of my talk, I'll present a background of main results achieved by my collegues in the 70's because their results have been our reference for a long time. In the second section, I'll speak of practical use of Pix by farmers. In the third section, I'll present our recent work in Cameroon, in which I'm personally involved. Finally, I'll give a conclusion and I'll present our approach for further growth regulant studies.

1. RESEARCH RESULTS IN THE 70's

Let me start the first section of my talk with an historical and geographical background. Experiments on growth regulants start in the 70's and were carried out in almost all the countries of what I call the Africa Cotton Belt. Growth regulants were thought to be usefull for rank and vegetative cotton crops: tall plants carrying few bolls. Rank crops are usual in the south margins of the cotton belt, near the forest areas, with rainy and cloudy climate and deep soils. Several chemicals were tested at the beginning of experimentation on growth regulants. But after a few years, only one remained : Pix.

Results on Pix experiments showed two main constant effects: reduction of height and an increase in earliness. The reduction of final height results from a reduction of internodes lenght. The increase in earliness expressed as the percentage of first picking results from more bolls set in the first nine sympodia. But yield results were erratic: yield were either increased, unchanged or decreased. Yields increases were recorded when control plants were tall, at high densities, and without rain or nitrogen limitations.

These results led to recommendations for practical use in humid areas: Pix should be applied in a single application at early bloom, at a rate 1 liter per hectare, if plants are taller than 80 cm.

Let me just mention that in the 80's some experiments carried out in typical savana areas, showed that final tall plants are not always a necessary or a sufficient condition for getting a yield increase with Pix.

2. PRACTICAL USE ON FARMS

I'm beginning with a brief background on cotton production in Africa, then I'll go on with technical requirements for the use of Pix, and I'll finish with the presentation of the concret example of Cote d'Ivoire.

Let me remind you of the dramatic increase of cotton production in Africa since the 60's. From around 100.000 tons of seed-cotton in 1960, the production of the french speaking coutries of Africa reached more than I M tons thirty years later. Nowadays, Africa fiber sales represent almost 10% of the international exchanges. Factors that explain this progression :

(1) the close links between research and cotton organisations

(2) the cotton organisations, that manage all the up-hill and down-hill components of production: training, inputs management, credit management, purchase of cotton, ginning, etc.

(3) the farmers, they are all small farmers. They grow food crops for self - consumption, but they have been very motivated for growing cotton, because cotton with attractive and guaranted prices has become their main cash crop. And they do all that with very low equipment.

Now I move to the technical requirements fox Pix use.

The possibility of using Pix depends on insecticide spraying equipments, as shown by next **table 1**. At the beginning, insecticides were sprayed with back - packs sprayers, that required relatively a lot of water. So it was so easy to combine Pix treatment with the first or the second insecticide treatment. Then in the 80's, came the Ultra Low Volume sprayers. Insecticide treatments became very easy, and that is one of the main factors for explaining the fantastic increase of african cotton production. But these sprayers need no water and Pix needs water.

Table 1. Insecticide spraying techniques and compatibility with Pix.

Insecticide spraying technique	**70's** LV back-packs	**80's** ULV 3 to 1 l/ha	**90's** VLV
WATER REQUIREMENT	100 l/ha	none	10 l/ha
efficiency	very high	medium	high
adoption by farmers	low	high	high
protection cost			lower
surfaces and yields		highly increased	
Pix COMPATIBILITY	YES	NO	YES ?

So Pix use became quite impossible, because it was not possible to have special equipment only for Pix. Recently, a new technic appeared : the Very Low volume, that requires10liters of water per hectare. Now, in theory, Pix use again became possible.

Now let us see the concret example of Cote d' Ivoire.

Cote d' Ivoire is in fact the only country in Africa where Pix has been used by farmers. The potential area in which Pix can be used, that is the humid area in the forest margins, is around 40.000 hectares. In the early 80's, Pix has been used, and well appreciated both by farmers and by cotton organisation. But with the event of the Ultra low volume, Pix use decreased and stopped. In 1990, research recomended again the use of back-packs, because back-packs sprayers are more efficient against mites ; then Cotton Organisation bought again Pix and farmers used it again. But in 92, there was a general economic reform, and certain inputs moved in the private sector. But the lack of guarantee for credit led to the failure of Pix sales to farmers. So there is a potential for Pix use in Cote d' Ivoire, but presently economical conditions among all partners concerned with cotton production are not fullfilled.

3. RECENT ACHIEVEMENTS IN CAMEROON

As a result of an increasing use of the very low volume (that is with 10 liters of water), in 1990 B.A.S.F. decided to promote Pix use in Cameroon. So we were obliged to supply references for decision aid for the cotton organisation and for farmers. Initially, the potential area for Pix use was supposed to be the most humid and productive area, where early sown fields exhibit tall plants. So we set up a series of tests in this area. These tests were carried out on farms, in 3 villages. We chose homogeneous fields that presented optimal initial conditions : early sowing, good growth. The tests were very simple : with and without Pix. It was a single application, at early bloom, in early August, what means that 2 rainy months were still available.

These tests gave us very interesting informations and results. The first result is that Pix has no problem with very low volume applications: as expected, leaves are dark green, height was reduced, reproductive developement was enhanced (for instance, two bolls at some nodes), and earliness increased in all cases.

As a second result, these tests clearly showed that :

- Pix accelerates cut-out, sometimes to a great extent,

- height reduction results not only from the reduction internodes length but also from the production of fewer nodes,

- Pix accelerates senescence and defoliation, and this could be an advantage against aphids, that are responsible of the major problem of sticky cotton,

- but Pix accelerates also regrowth, and in a strong way because residual soil moisture is still available. So previous advantage against aphids becomes a great disadvantage because of late and long harvest.

The third result is that yield responses are not constants. The yield responses were different in the 3 villages, but rather homogeneous inside the villages (heterogeneous tests were eliminated). So, the cases of these 3 villages represent a typology, as shown by **table 2.** Initial

Table 2. Typology of yield responses to Pix. Cameroon 1990

	initial conditions		control		Pix response	
Village	bloom level *	height (cm)	final height	yield (qx/ha)	final height	yield response
V.1	1.5	80	130	26.5	105	-0.5
7 tests			low	medium	(- 25cm)	negative
V.2	1.4	85	150	24.5	135	+ 2.5
9 tests			medium	low	(- 15 cm)	positive
V.3	1.1	85	170	29.0	135	0
7 tests			high	high	(- 35 cm)	neutral

* range of the fruiting branch with a white bloom in first position

conditions are almost equivalent in the 3 cases : White bloom between the first and the second fruiting branch and plants 80 to 85 cm tall. In the first case, control has short plants, and medium yields, and the yield response to Pix is negative; control plants exhibit naturally a very good reproductive/vegetative balance, may be due to a moderate water stress because of less rain in August. In the second case, control exhibits medium tall plants, and low yields, that is a bad reproductive / vegetative balance, and yield response to Pix is very positive. In the third case, control exhibits both tall plants and high yields, and Pix has a big effect in reducing height, but no effect on yield. This is very interesting because with tall plants, this case was supposed to be the ideal situation for Pix use. In both second and third cases, plants were 85 cm tall at early bloom, and 1m 35cm at least. Pix led more or less to the same control of height growth, and cut - out occured more or less at the same time. On the other hand, control plants were 1m 50cm in one case, against 1m 70cm in the other case. In the last case, growing season was longer, and more late bolls could compensate for the additional early bolls set by Pix. This longer growing season was probably due to deeper soil, and deeper roots maybe due to less rain in June.

These results led us to formulate the hypothesis that Pix can increase both earliness and yields when the growing season is short. But if growing season is long, plants without Pix will produce more bolls and conpensate. This hypothesis is consistent with farmers opinions : they said bolls were bigger with Pix, but they generally refused height reduction, except in the cases where yields increases were obvious.

In the following year, 2 statistical experiments with late sowing dates and good growth rates confirmed our hyrothesis. One of these 2 trials was carried out in a colonisation village with rich soils. Farmers said to be interested in testing Pix in their fields. So in the following year, 20 of them treated their late sown fields with Pix. Their observations on Pix effects were actually very accurate, and their appreciation of Pix was very positive. But when we announced them the price of Pix, their opinion was not the same. Pix was said too expensive, and seed cotton price too low. They needed almost 100 kg of seed cotton to pay 1 liter of Pix. With the same money, they could almost pay the new low cost protection program for the entire season.

CONCLUSION

Nowadays in Africa, previous conditions for Pix use on farms are the possibility of combining Pix with insecticide treatments and the organisation of credit facilities for farmers. In addition, as Pix is a costly chemical, yields should be highly increased and economic risks well evaluated. This means that Research has to work on the elaboration of simple but accurate tools for decision aid.

On basis of CIRAD achievements, two clear applications have been identified for Pix : first, rankness or "vegetative growth", and recently, short season cotton. Short season can result either from late sowing in areas with long rainy season, or from early sowing in areas with short rainy season. Good growth rates are necessary before and even after the Pix treatment, so stress should be avoided. Although rates of risks are high, short season cotton dramatically increases the potential acreage for Pix application.

I'd like to underline here that Cameroon results for short season cotton are sonsistent with CIRAD results in Montpellier, France, with quite different cultivars. In 1982, growing season was shortened because of cold weather in September, and Pix resulted in a yield increase. On the other hand, in 1989 and 1990, growing season was longer and Pix did not increase yields. These results are also consistent with american literature. I think this example shows that even with very different conditions, some problems are similar in essence. The integration of these trials from so different countries in the same analysis framework supposes a very accurate monitoring of environmental conditions and of the crop development. I think that our future work should lead to predict Pix effects in a large range of cropping conditions. CIRAD position, and my own position too, is that the use of crop simulation models as a research tool is indispensable. And I think that for such ambitious purpose we should join our forces, and a larger cooperation is suitable.

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