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Editorial / Editoriaal

Il y a maintenant près de quinze années que Tropicultura ouvre ses colonnes aux praticiens et aux scientifiques qui se soucient du développement rural des pays tropicaux les moins avancés. Conçue initialement comme une revue qui remplirait le rôle joué avant 1963 par le prestigieux Bulletin agricole du Congo Belge et du Ruanda-Urundi, Tropicultura a, depuis son commencement, traité de problèmes dont l'intérêt scientifique et technique dépassait largement les limites de l'Afrique Centrale. Aux articles des coopérateurs, des experts et des scientifiques belges ou formés en Belgique, qui constituaient l'essentiel des premiers numéros de la revue, sont venues s'ajouter de plus en plus de publications provenant d'horizons les plus divers. A tel point que l'on peut considérer à présent que permettre aux auteurs des pays en voie de développement de faire connaître au monde leurs expériences et leurs découvertes, si nécessaire en les aidant dans la rédaction de leurs articles, est devenu un des objectifs prioritaires de la revue.

Il faut croire que cette initiative répondait et répond toujours à un besoin important au niveau des acteurs du développement rural des zones tropicales puisque son succès n'a fait que grandir au fil des ans. Vous êtes actuellement près de 2 500 à recevoir Tropicultura tous les trois mois dans plus de 110 pays du monde et chaque mois nous arrivent de nouvelles demandes d'abonnement.

Ce succès est dû en grande partie à Monsieur Jacques Hardouin qui a dirigé le comité de rédaction de la revue depuis sa création. Au moment de lui succéder à ce poste, je tenais à rendre hommage à la grande qualité de son travail et à son dévouement sans limite.

En tant que nouveau rédacteur en chef, il m'est particulièrement agréable de vous annoncer une bonne nouvelle concernant la continuation de la parution de notre revue. L'AGCD vient en effet de marquer son accord pour renouveler pour cinq ans la convention qui la lie à l'asbl Agri-overseas, responsable de l'édition de Tropicultura. Vous devriez donc pouvoir continuer à nous lire fidèlement aux cours des années qui viennent. Je peux vous assurer que nous mettrons tout en oeuvre pour ne pas décevoir vos attentes et garder le niveau de qualité et d'intérêt auquel vous a habitué la précédente équipe de rédaction.

La parution de notre revue serait impossible sans les efforts consentis bénévolement par les rédacteurs délégués et les nombreux lecteurs qui acceptent de critiquer les articles qui leur sont soumis. En votre nom à tous, fidèles lecteurs, je les remercie sincèrement pour leur contribution et espère pouvoir compter encore longtemps sur leur dévouement.

Avant de vous quitter, j'attire particulièrement votre attention sur la nécessité de bien remplir et nous renvoyer dans les meilleurs délais le petit talon réponse qui se trouve à la dernière page de ce numéro. Il s'agit à la fois d'un petit questionnaire destiné à nous permettre de mieux évaluer l'impact de Tropicultura dans le monde et d'une demande de renouvellement de votre abonnement.

Toute personne qui n'aura pas renvoyé ce formulaire dans les trois mois sera retirée de la liste de nos abonnés.

Vijftien jaar geleden werd Tropicultura opgericht zodat practici en onderzoekers, begaan met de ontwikkeling van landbouw en veeteelt in de armste tropische landen, de mogelijkheid zouden krijgen, hun experimenten te publiceren. Oorspronkelijk zou dit tijdschrift het befaamde «Bulletin agricole du Congo Belge et du Ruanda-Urundi» dat tot in 1963 verscheen, vervangen. Reeds van in het begin verschilde «Tropicultura» echter van het bovengenoemd tijdschrift door de publicatie van artikels waarin wetenschappelijke en technische problemen van ver buiten Centraal Afrika besproken werden.

In de loop der jaren werd er naast de artikels van cooperanten en Belgische wetenschapslui meer en meer wereldwijd gepubliceerd. Daardoor kan men stellen dat tegenwoordig het voornaamste doel van «Tropicultura» is om aan de auteurs uit ontwikkelingslanden eveneens de gelegenheid te geven hun experimenten en bevindingen kenbaar te maken.

Het doel van «Tropicultura» was en is nog steeds om te voldoen aan de nood van ontwikkelingshulpers die instaan voor landbouw en veeteelt. Gezien het toenemend succes der laatste jaren kan men veronderstellen dat men daar grotendeels in geslaagd is. Op het ogenblik tellen we namelijk 2 500 abonnees van uit meer dan 110 landen en elke maand komen er nog nieuwe aanvragen binnen.

Het succes van «Tropicultura» danken wij grotendeels aan de heer Jacques Hardouin die van in het begin de verantwoordelijkheid op zich nam voor de redactie van het tijdschrift. Nu verlaat de heer Hardouin onze redactie en wil ik, als nieuw hoofdredacteur, van de gelegenheid gebruik maken om hem hulde te brengen voor zijn werk en grenzeloze inzet.

Ik ben zeer verheugd te kunnen meedelen dat ons tijdschrift zal blijven verschijnen. Het ABOS heeft namelijk de samenwerking met Agri-Overseas, verantwoordelijk voor de uitgave van «Tropicultura», voor vijf jaar verlengd. Het tijdschrift zal dus zeker verder verschijnen in ik kan jullie verzekeren dat alles zal gedaan worden om de kwaliteit en de interesse dat het tijdschrift tot nu toe genoot, te bewaren.

«Het uitgeven van ons tijdschrift zou onmogelijk geweest zijn zonder de vrijwillige inspanningen van de gedelegeerde redacteurs en van de talrijke referees die bereid gevonden waren de ingestuurde artikels kritisch te beoordelen. In naam van u allen, trouwe lezers, dank ik hen van harte voor hun bijdrage en hoop nog lang op hun inzet te mogen rekenen.»

Vooraleer af te sluiten wil ik jullie vragen de antwoordstrook (op de laatste pagina van dit nummer) volledig ingevuld, zo spoedig mogelijk terug te sturen. Het betreft naast de hernieuwing van het abonnement, eveneens een kleine vragenlijst die ons moet toelaten de wereldwijde bekendheid van «Tropicultura» na te gaan.

Indien deze antwoordstrook niet teruggestuurd is binnen de drie maanden zal de abonnee automatisch van onze lijst geschrapt worden.

Virtually fifteen years have elapsed since Tropicultura first welcomed contributions by experts and scientists concerned about the rural development of the least advanced tropical countries. Designed initially as a journal to carry on the function assumed up until 1963 by the prestigious "Bulletin agricole du Congo belge et du Ruanda Urundi", Tropicultura has from the outset, addressed issues of scientific and technical interest which greatly transcend the limits of Central Africa. To the earliest articles written by junior and senior experts and scientists either Belgian or trained in Belgium, which were the mainstay of the first issues, have been added an increasing number of publications from many different horizons. To such an extent that to enable authors from developing countries to share their experiences and discoveries with the rest of the world by helping them where necessary to write their articles, has currently become one of the main objectives of the journal.

It would seem that this initiative fulfilled an important need, and still does, for key players in rural development of tropical areas, since its success has steadily increased over the years. There are currently around 2 500 of you who receive Tropicultura every three months in over 110 countries around the world and each month we get requests for new subscriptions.

Credit for this success is due largely to Mr Jacques Hardouin who has been in charge of the editorial committee since the creation of the journal. Before I take over this position from him, I would like to pay tribute to the very high quality of his work and his unlimited dedication.

As the new editor, it gives me great pleasure to announce the good news concerning the publication of our journal. The BADC has just agreed to renew for a further five years the convention which links it to Agri-overseas, responsible for the publication of Tropicultura. You should therefore be able to continue to enjoy reading our journal in the future. We assure you that we will do our utmost to live up to your expectations and to maintain the high level of quality and interest which was the trademark of the previous editorial team.

The publication of our journal would not be possible without the dedicated voluntary work by the editorial team and the many readers who act as referees. On behalf of all of you, as faithful readers, I thank them sincerely for their contribution and hope we can count on their dedication for many years to come.

Before I conclude, I would like to draw your attention particularly to the need of filling in correctly and sending us fairly rapidly the reply form which you will find on the last page of this issue. It is both a short questionnaire designed to help us better appraise the impact of Tropicultura around the world and a request to renew your subscription.

Please note that any person who has not returned the form within three months will be erased from our list of subscribers.

Hace ya 15 años que «Tropicultura» ha abierto sus columnas a los hombres de terreno y a los científicos que se preocupan del desarrollo rural de los países tropicales menos avanzados. Desde su inicio, «Tropicultura» trata problemas que depasan largamente los límites de África Central, a pesar que fue concebida inicialmente como una revista destinada a llenar el rol jugado hasta 1963 por el prestigioso "Bulletin agricole du Congo belge et du Ruanda Urundi". A los artículos de los cooperantes, de los expertos y de los científicos belgas o formados en Bélgica, que constituyen lo esencial de los primeros números de la revista, hay que añadir publicaciones provenientes de diferentes latitudes, las que además que no cesan de incrementar. A tal punto que ahora podemos considerar esta revista como un medio que permite a los autores de los países en vías de desarrollo presentar al mundo sus experiencias y sus descubrimientos, si es necesario, ayudándoles en la redacción de sus artículos.

Hay que estar consiente que esta iniciativa respondió y responde a una necesidad real e importante de los actores del desarrollo rural de las zonas tropicales. Esto explica que el éxito de esta revista no deja de aumentar a través de los años. En la actualidad, aproximadamente 2 500 personas reciben «Tropicultura», cada tres meses, en más de 110 países en el mundo y cada mes recibimos nuevas demandas.

Este éxito es debido en gran medida al señor Jacques Hardouin que ha dirigido el comité de redacción de la revista desde su creación. Al momento de remplazarlo en este cargo, yo tengo que rendir homenaje a la gran calidad de su trabajo y a su dedicación sin límite.

Como nuevo jefe de redacción, me es particularmente agradable anunciarles una buena noticia: esta revista seguirá apareciendo en el futuro. En efecto, la AGCD acaba de renovar por 5 años más el contrato que la liga a la ONG «Agri-overseas», responsable de la edición de «Tropicultura». En consecuencia, ustedes podrán continuar leyéndola los 5 años venideros. Yo les puedo asegurar que haremos todo lo posible para no decepcionar sus expectativas y trataremos de mantener el nivel de calidad y de interés al cual les ha habituado el equipo de redacción precedente.

La aparición de nuestra revista sería imposible sin los esfuerzos benévolos de los redactores delegados y de los numerosos lectores que aceptan criticar los artículos que se les hace llegar. A ustedes, fieles lectores, no me queda más que agradecerles sinceramente por su contribución, esperando contar con su deferencia aun por largo tiempo.

Antes de despedirme, tengo que llamar particularmente su atención sobre la necesidad de llenar convenientemente el pequeño talonario de respuesta que se encuentra en la última página de este número y hacernos llegar lo más rápidamente posible. Se trata a la vez de un pequeño cuestionario destinado a evaluar de una mejor manera el impacto de «Tropicultura» en el mundo y una solicitud de renovación de abonamiento.

Toda persona que no retorne este formulario en tres meses, será retirada de la lista de abonados.

G. Mergeai
Administrateur délégué

ARTICLES ORIGINAUX

OORSPRONKELIJKE ARTIKELS

ORIGINAL ARTICLES

ARTICULOS ORIGINALES

Effects of Low Plane of Nutrition on the Development of Lean Muscle, Bone and Fat in the West African Dwarf Goats of Nigeria

A.A. Awah* & I.O.A. Adeleye**

Keywords: Dwarf goat - Under nutrition - Muscle - Bone - Fat.

Summary

Thirty West African Dwarf goat kids were raised on low plane of nutrition from 5 days old to 52 weeks of age. They were serially slaughtered at 2, 8, 12, 24 and 52 weeks old to study changes in liveweight and the development of lean muscle, bone and fat.

Lean muscle and fat expressed as the percentage of empty body weight (E.B.W.) increased from 32.5% and 3.5% at 2 weeks to 42.0% and 9.4% at 52 weeks respectively. These increases at 52 weeks old represented about 544.9% and 1093.3% over their respective weights at 2 weeks old. The bone tissue increased to about 307.3% at 52 weeks old over its weight at 2 weeks of age, but decreased from 15.4% E.B.W. at 2 weeks to 10.9% E.B.W. at 52 weeks of age.

Lean muscle was consistently the largest carcass tissue from 2 weeks to 52 weeks of age followed by the bone tissue, while fat was the least.

Female goat kids entered the rapid fattening phase at about 38 weeks of age (6.9 kg liveweight), but the males did not enter the rapid fattening phase, even at 52 weeks of age (11.8 kg liveweight).

Résumé

Trente chevreaux de race naine d'Afrique occidentale ont été soumis à un régime pauvre depuis l'âge de 5 jours jusqu'à 52 semaines. Ils ont été abattus par lots à 2, 8, 12, 24 et 52 semaines afin de suivre les variations du poids vif et du développement des muscles maigres, des os et de la graisse.

Les muscles maigres et la graisse en pourcentage du poids du corps vide a respectivement augmenté de 32,5 % et 3,5 % à 2 semaines et jusqu'à 97,8 % et 9,4 % à 52 semaines. Les poids observés à 52 semaines représentaient à peu près 544,9 % et 1093,3 % du poids à 2 semaines. Le poids de l'os augmentait de 307,3 % entre 2 et 52 semaines mais diminuait en pourcent du poids vide de 15,4 % à 2 semaines à 10,9 % à 52 semaines.

L'augmentation du poids du muscle maigre de 2 à 52 semaines était la plus importante suivie par celle de l'os, puis celle de la graisse.

L'âge d'engraissement des chevrettes commençait à peu près dès l'âge de 30 semaines (6,9 kg de poids vif) tandis que les chevreaux n'entraient pas en phase d'engraissement rapide même à 52 semaines (11,8 kg de poids vif).

Introduction

In studies of meat animals, the Scientist is primarily concerned with the growth of the major tissues of the carcass which are lean muscle, bone and fat and with the proportions of these three major tissues in the carcass. Carcass weight as an end point for growth in meat animals is therefore more useful than liveweight since the later includes non-soleable components of the animal and its gut contents. The main problem with carcass weight is one of assessing its yield of high value tissues and cuts. Age, weight, breed, sex, nutritional history and other factors influence the pro-

portions of muscle, bone and fat at any particular stage of weight increase (2, 3, 4, 5, 9,). Because goats are mostly kept under traditional husbandry system in Nigeria, information on their economic returns as meat animals are limited.

In a previous study (1), some information were gained on the development of lean muscle, bone and fat in the West African Dwarf (WAD) goats of Nigeria maintained on good plane of nutrition. The period the carcass had a maximum of lean muscle, a minimum of

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bone and optimum amount of fat occurred later in the life of male goat kids and at heavier liveweight than the female goat kids.

Very little attention had been hitherto devoted to investigations on the merits or limitations of WAD goats for meat production in a well defined set of conditions. The present paper reports a further study on the development of lean muscle, bone and fat in the WAD goats maintained on low plane of nutrition from 5 days old to 52 weeks of age.

Material and methods

Thirty WAD goat kids were obtained from the University of Ibadan Teaching and Research farm at 5 days of age after they had suckled their dams to obtain colostrum.

They were separated into two groups consisting of 15 males and 15 females to avoid indiscriminate mating at later age. The management of the two groups of the experimental animals was the same.

From 5 days to 2 weeks of age, the kids were fed with fresh cow milk warmed to 37° C at half appetite level (1) thrice daily at 08.00, 13.00 and 18.00 hours. The centesimal and proximate chemical composition of solid feeds fed to the animals are presented in Table 1. From 2 weeks of age the milk diet was supplemented with pre-weaning creep feed at half appetite level (1) and chopped giant star grass (*Cynodon nlemfuensis* var *Robustus*) *ad libitum*. A gradual withdrawal of milk from the diet of the kids was embarked upon during the 5th week of life. This was accomplished by feeding the kids with warmed milk twice daily (08.00 and 13.00 hrs) for the first 4 days and once daily for the last 3 days of week five. By the end of the 5th week, milk feeding was completely stopped and all kids were on pre-weaning creep feed and chopped grass. From the 13th week of age, the pre-weaning creep feed was replaced with post-weaning feed at half appetite (1). All animals had free access to salt lick and fresh water supply.

Six animals (3 males and 3 females) were serially slaughtered at 2, 8, 12, 24 and 52 weeks of age to study the growth of lean muscle, bone and fat in the carcass.

Slaughter method

A day prior to slaughter, all animals to be slaughtered were weighed to obtain their liveweight. They were then subjected to an 18-hr. fast, weighed and then slaughtered, dressed, chilled and then dissected according to the standard muscle groups (4). Briefly, this involved separation of the right side of the carcass into its individual muscle groups, associated bones and four major fat depots (intermuscular, subcutaneous, kidney and channel).

Analytical procedure

All dissected lean muscle, bones and fat were weighed according to their anatomical locations, then combined, weighed and multiplied by two for subsequent calculations of total lean muscle, bone and fat.

TABLE 1
Centesimal and chemical composition of pre-and post-weaning creep feeds and *Cynodon nlemfuensis*.
(a) Centesimal composition

Ingredient (%)	Pre-weaning feed	Post-weaning feed	<i>Cynodon nlemfuensis</i> (grass)**
Cassava flour	31.5	39.0	-
Dried bewers grain (milled)	20.0	20.0	-
Soya bean (meal)	40.0	40.0	-
Sucrose	2.5	-	-
Glucose	5.0	-	-
Dicalcium phosphate	0.5	0.5	-
Mineral/vitamin mixture*	0.5	0.5	-
	100.0	100.0	

* Mineral/vitamin mixture :

Content in g/kg, Manganese 16.0 ; Zinc 12.0 ;

Iron 6.0 ; Copper 4.0 ; Cobalt 0.30 ; Iodine 1.20 ;

Magnesium 200.0 , Vitamin A. 0.50 IU and vitamin D. 0.25 IU.

(b) Chemical composition

Constituent on a DM basis

Constituent	Pre-weaning feed	Post-weaning feed	<i>Cynodon nlemfuensis</i> (grass)**
Fresh weight dry matter	-	-	43.4
Residual dry matter (DM)	94.5	95.0	93.4
Organic matter	91.0	91.5	87.2
Crude protein (N x 6.25)	19.7	18.8	4.9
Crude fibre	7.4	8.0	32.10
Ether extract	7.0	9.0	1.0
Nitrogen free extractives	56.9	55.7	49.4
Ash	3.5	3.5	6.1
Gross energy (Kj/100 g)	384.1	410.4	451.4

** *Cynodon nlemfuensis*

Chemical composition on a DM basis, each value is mean for 52 determinations from January to December

The growth coefficients for lean muscle, bone and fat were estimated by the use of the allometric growth equation, $Y = aX^b$ (2). Where Y = the respective tissue weight (or part); X = the corresponding weights of muscle plus bone (or whole); a = intercept; b = the growth coefficient of the respective tissues.

Data obtained from this study were subjected to analysis of variance. Significant differences were estimated by the use of Duncan's multiple range test (11).

Results

The growth of the WAD goats at the five stages is presented in Table 2. The mean liveweight at 52 weeks of age was 10.20±0.92 kg. The empty body weight (E.B.W.), the dressing out percentage and all the carcass tissues studied increased with advancing age.

The dressing out percentage increased only slightly from 44.4 ± 0.47% at 2 weeks old to 45.2 ± 0.11% at 52 weeks of age. Lean muscle increased from 538.9 ± 39.96 g. (32.5 ± 0.04% E.B.W.) at 2 weeks old to 2936.3 ± 283.6 g. (42.0 ± 0.28% E.B.W.) at 52 weeks of age. Total dissectible carcass fat increased from 58.8 ± 6.89 g. (3.5 ± 0.22% E.B.W.) at 2 weeks old to 642.3 ± 31.08 g. (9.4±0.89% E.B.W.) at 52 weeks of age. Total carcass bones also increased with advancing age from 247.5±11.62 g. at 2 weeks old to 760.6 ± 67.26 g. at 52 weeks of age.

Lean muscle was consistently the largest of the three carcass tissues from 2 weeks to 52 weeks of age, followed by the bone tissue, while fat was the least.

TABLE 2
Live weight and weights of certain body components of the West African Dwarf goat as affected by age.

Parameters	2 weeks	8 weeks	12 weeks	24 weeks	52 weeks
Live weight at slaughter (kg)	1.75±0.12	3.28±0.19	4.08±0.34	5.33±0.34	10.20±0.92
Empty body weight (E.B.W.) (kg)*	1.65±0.13	1.68±0.19	3.04±0.25	3.88±0.23	6.98±0.63
E.B.W. as % of liveweight (%)	94.29	81.70	74.51	72.80	68.43
Total dry matter intake g/day	30.98±4.43	75.39±6.51	115.69±19.57	143.18±4.06	260.48±7.16
Dressing out percentage (%)	44.42±0.47	44.49±0.65	44.52±0.09	44.61±0.27	45.22±0.11
Total lean muscle (side tissue x 2) (g)	538.90±39.96	1046.28±74.14	1221.70±106.91	1611.57±115.51	2936.33±283.56
As % of E.B.W. (%)	32.50±0.04	39.10±0.07	40.12±0.37	41.50±0.51	42.03±0.28
Total carcass bone (side tissue x 2) (g)	247.52±11.62	375.39±21.62	398.52±29.79	464.41±29.20	760.55±67.26
As % of E.B.W.	15.38±0.45	14.07±0.21	13.13±0.08	11.92±0.04	10.92±0.20
Total dissectible fat (side tissue x 2) (g)	58.75±6.89	113.86±10.02	146.31±5.67	299.86±5.78	642.32±31.08
As % of E.B.W. (%)	3.53±0.22	4.25±0.18	4.87±0.28	7.82±0.47	9.42±0.89
Muscle : Bone ratio	2.17±0.17	2.63±0.24	3.06±0.08	3.46±0.05	3.86±0.12

*Empty body weight (E.B.W.) = Live weight at slaughter minus the gut contents.

These increases at 52 weeks old represented about 544.0%, 307.3% and 1093.3% over the respective weights of lean muscle bone and fat at 2 weeks of age. The ratio of muscle to bone was about 2:1 at 2 weeks old. The ratio increased to about 4:1 at 52 weeks of age.

Table 3 shows the effect of sex on the liveweight and growth of carcass tissues in the WAD goat kids. Male goat kids weighed significantly ($P < 0.05$) heavier than the females from 12 weeks of age. They also had consistently heavier carcass muscle weight than the females and the difference was significant from the 12th week of age. Carcass bones of male goat kids were heavier than those of the females, but the difference was only significant ($P < 0.05$) at 52 weeks of

age. The weight of fat in the carcasses of both sexes was similar ($P > 0.05$). Extrapolations of tissue weight (lean muscles, bone, fat) on liveweight or age, indicated that the weight of fat in the carcass of the female goats equalled those of the bones at about 6.9 kg liveweight (about 38 weeks of age) and thereafter exceeded the bones. Fat in the carcasses of the male goats never equalled the weight of the bones. even at 52 weeks of age.

The growth coefficients of the three major carcass tissues, lean muscle, bone and fat are presented in Table 4. The growth coefficient for the bones was less than one (0.87), intermediate for lean muscle (1.04) and high for fat (1.48).

TABLE 3
Sex effect on the liveweight and weights of muscle, bone and fat (side tissue x 2) of the West African Dwarf goat as affected by age.

Age of goat kids	Liveweight at slaughter (kg)		Total lean muscle		Total carcass bones (g)		Total dissectible fat (g)	
	Male	Female	Male	Female	Male	Female	Male	Female
2 weeks	1.83 ±0.28	1.68 ±0.03	574.49 ±83.18	503.31 ±11.45	245.61 ±28.19	249.43 ±2.85	61.46 ±14.79	56.04 ±7.11
8 weeks	3.60 ±0.10	2.97 ±0.04	1171.74 ±24.30	920.82 ±30.21	411.12 ±5.52	339.65 ±14.85	128.90 ±3.23	98.82 ±11.80
12 weeks	4.65 ±0.15	3.50 ±0.10	1403.06 ±52.83	1040.33 ±19.90	448.26 ±19.12	348.77 ±2.91	153.02 ±7.96	139.60 ±6.29
24 weeks	5.90 ±0.10	4.75 ±0.05	2414.24 ±25.66	1808.89 ±38.97	514.13 ±11.94	414.68 ±5.50	301.15 ±0.70	298.58 ±14.04
52 weeks	11.75 ±0.55	8.70 ±0.40	3395.14 ±213.82	2477.50 ±125.28	873.61 ±18.19	646.63 ±35.54	633.81 ±54.97	650.84 ±51.29

TABLE 4
Growth coefficients (b) of component tissues (Y) from the relationship $\log_{10} Y = a + b \log_{10} X$; Where X = Muscle plus bone, from dissection data for West African Dwarf goats maintained on low plane of nutrition.

Dependent variable (Y)	Intercept (a)	Regression coefficient (b)	Standard error (SE)	Correlation coefficient (r)
muscle	-0.694	1.040	0.059	99**
bone	-0.701	0.869	0.033	99**
fat	-1.989	1.476	0.074	96**

** ($P < 0.01$).

Discussion

The fastest growth rate of about 36 g/day by the WAD goats was obtained at between 2 and 8 weeks of age. This was in good agreement with the period of fastest growth rate (about 79 g./day) obtained for WAD goats maintained on good plane of nutrition (1). Early post-natal period has been shown to be the period a calf doubles its birth weight (5).

Results obtained with the WAD goats in the two sets of experiments not only confirmed the above statement, but also indicated clearly that plane of nutrition

merely affected the rate of weight gain per day, but did not alter the pattern of early post-natal growth. Values on the rate of gain after birth for goats are extremely limited. A range from 18 g/day for native breeds to over 200 g/day post-weaning for improved breeds on high plane of nutrition had been reported (9). Differences among breeds in size at maturity as well as other factors are known to affect rate of growth. The WAD goat apart from being small in size even at maturity, is a slow growing animal (6), reaching a mean liveweight of about 14kg in the humid forest areas of Nigeria in 12 months (1)* The WAD goats in the present study attained a mean liveweight of about 10 kg in 12 months of age.

The dressing out percentage changed very little from 2 weeks to 52 weeks of age, representing only about 1.8% increase as against 3.4% increase over the same period of time for WAD goats maintained on good plane of nutrition. The E.B.W. increased progressively with age, but when the E.B.W. was expressed as the percentage of liveweight, decreased consistently from 92.2% at 2 weeks old to 68.4% at 52 weeks of age. In comparison the E.B.W. of the group of WAD goats maintained on good plane of nutrition also decreased as the percentage of liveweight from 91.3% at 2 weeks to 73.6% at 52 weeks of age. This is indicative of the fact that the digestive tract and its contents were in both cases increasing at faster rate than the liveweight.

The mean proportion of lean muscle, bone and fat relative to total carcass weight at both 2 and 52 weeks of age were lean muscle, the largest (544.9% increase), followed by the bone tissue (307.3% increase) and fat, the least (1093.3% increase). This contrasts sharply with earlier results obtained with the WAD goats maintained on good plane of nutrition at 52 weeks of age, where the proportion of the carcass tissues were, lean muscle, the largest (673.2% increase) followed by fat tissue (2090.8% increase) and the bone tissue, the least (220.7% increase). Information in the literature, mostly from sheep and cattle show that lean muscle comprised the highest percentage of the carcass at birth, then followed by fat and that bone tissue at no stage exerted a dominant role in the determination of the relative proportions of the three major carcass tissues (4). The results obtained with the WAD goats of Nigeria in the two sets of experiments at 2 weeks of age is at variance with the above statements. However, interpretation of data on the relative growth of tissues in meat animals must be made to the exclusion of confounding factors that tend to shroud clear vision of intrinsic and extrinsic causes and effects. For example, it has been demonstrated that goats lay more fat in the visceral organs than sheep and cattle (8,9) and that goats are characterized by sparse fat covering over the external body surface and a large accumulation of fat around the kidneys even feral goats (10). Thus species difference in fattening pattern has well been documented in the literature. The low fat accretion in the carcasses of the WAD goats in the present experiment, even at 52 weeks of age, could be attributed to the animal species on one hand and to effects of low plane of nutrition on the other hand.

Similar to other domestic species of livestock, the male WAD goats gained faster than the females both in the present experiment and in the previous ones maintained on good plane of nutrition. Male goats usually gain faster in the earlier months of life, but as they reach sexual maturity they become temperamental, feed intake is reduced and gain slowed (9). The influence of sex on the relative growth of lean muscle, bone and fat showed that male goats had significantly ($P < 0.05$) heavier lean muscle than the females even from 12 weeks of age and significantly ($P < 0.05$) heavier bones only at 52 weeks of age.

Although the amounts of fat accretion in the carcasses of both sexes of goats in the present study was similar ($P > 0.05$) even at 52 weeks of age, yet the female goats entered the rapid fattening phase at about 38 weeks of age (about 6.9 kg liveweight), while the males did not enter the rapid fattening phase even at 52 weeks of age (11.8 kg liveweight). The rapid fattening phase refers to the period when the growth of carcass fat equals the bone tissue in weight. Results from the previous study, showed that female WAD goats maintained on good plane of nutrition entered the rapid fattening phase at about 28 weeks of age (9.0 kg liveweight) and the males at about 43 weeks of age (12.1 kg liveweight). This is indicative of the fact that good plane of nutrition not only increased the rate of liveweight gain, but also enhanced the onset of rapid fattening phase in both sexes. Predisposition to fattening is inversely related to gonadal androgen levels» and the androgenic effect of the male hormones consequently are necessary to complete a full pattern of muscle development (3).

Due to early development of bone and later development of muscle, the ratio of lean muscle to bone at 2 weeks of age was about two parts of lean muscle to one part of bone. During subsequent growth, bone tissue grew at a steady but slow rate and muscle at a relatively fast rate, so that at 52 weeks of age, the ratio increased to about four parts of lean muscle to one part of bone. Results of the application of the allometric growth equation, $y = aX^b$ (2), further substantiated the above statements. Thus, the growth coefficient for the bone was less than one (0.87), indicating that the bone tissue was growing at a low impetus rate, intermediate for muscle (1.04), which was growing at an intermediate impetus rate and high for fat (1.48), which was growing at high impetus rate. The above observations were again in good agreement with the lean muscle: bone ratio and the growth coefficients obtained for the WAD goats maintained on good plane of nutrition (1). Thus, plane of nutrition affected the rate of growth of the three major carcass tissues, but did not alter the muscle: bone ratio and the growth coefficients of the tissues.

This could be explained in part by the fact that undernutrition of young growing animals results in continued growth (even if the undernutrition is severe enough to cause a decrease in body weight) and also a homeostatic mechanism of body organs adjust cellular activity to systemic demand thus limiting organs size or restore this size after tissue had been lost (4,7).

The WAD goat farmer in this country manages his flock under traditional system of animal husbandry, resulting in poor growth and finished animals for the market at much longer time and lower liveweight. For greater economic advantage, the WAD goat farmer

can thus utilize the growth advantages of improved nutrition and management practices to manage his flock in order to produce animals for the market at relatively shorter period of time and at heavier liveweight.

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Anophelinocidal Activity of Volatile Oil from *Tagetes minuta* L. (Asteraceae).

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Key words: Anophelinocidal activity - Flower extract - Volatile oil - *Tagetes minuta* - Republic Democratic of Congo.

Summary

Tagetes minuta, a common weed found throughout Republic Democratic of Congo is used by native population to drive away insects. Volatile oil from flowers extract is endowed with anophelinocidal activity which remains for about seven days. The LD90 and LD50 of the crude extract are respectively of 75 mg and 45.6 mg/ml.

Résumé

Tagetes minuta, une herbe très répandue en République démocratique du Congo, est utilisée par la population locale pour chasser les insectes. L'huile volatile extraite de ses fleurs est dotée d'un pouvoir anophelinocidal qui agit pendant près de sept jours. Les LD90 et LD50 de l'extrait brut sont respectivement de 75 mg et 45,6 mg/ml.

Introduction

An entomological survey conducted at Lwiro (Kivu province, Eastern Republic Democratic of Congo, 1750 m of altitude) from 1988 to 1992 allowed to identify six species of the genus *Anopheles*: *A. gambiae*, *A. funestus*, *A. marshalli*, *A. demeilloni*, *A. coustani* and *A. christyi*. The two first species attain a prevalence rate of 97.5 % and are the major vectors of malaria in the study area where they are present throughout the year (1,7).

Malaria infection is a real problem for the public health in the tropics. It is the most devastating of the tropical diseases widespread in about 100 countries in which 270 millions of persons are infected and 2 millions die annually (7). In Republic Democratic of Congo, the malaria infection is endemic but the degree of endemicity varies from one region to another: at Lwiro is a mesoendemicity level of malaria according to the international classification observed (10), which is characterized by a parasite rate range between 11 % and 50 %.

The hypoendemic situation observed between 1960 and 1980 (parasite rate less than 10 %) has unfortunately evolved to a mesoendemic level and infants which age varied between 1 to 4 years are the most struck by the malaria infection due to the presence and predominance of *Plasmodium falciparum* (96.37 % among the positive cases), known to be the most human mortal plasmodial species (1). At Lwiro, malaria is the main cause of consultation where 20 % of hospitalization cases are caused by malaria infection among which a rate of 8% of deaths are observed annually (3).

To solve this problem integrated curative and preventive measures are needed. Moreover, plasmodium strains show resistance to common drugs such as chloroquine (16) and vectors are also resistant to insecticides which are considered as pollutants. Thus, one of the advisable methods of prevention of malaria infection consists in the reduction of manmosquito contact by using substances able to kill or to drive away vectors (7). Several of these substances are from plant origin (5, 6, 9).

With the aim of searching new, cheap and efficient drugs endowed with mortal activity against mosquitoes, a biological screening was undertaken on the chloroformic extract of flowers of *Tagetes minuta* L. (Asteraceae).

The present laboratory work deals with the in vitro anophelinocidal activity of the aforementioned plant.

Tagetes minuta L. is a weed of Bresilian origin introduced in Republic Democratic of Congo where it is now often seen, growing in uncultivated areas which are kept as fallow. Its aerial parts are used by native population for driving away insects (ants) out of dwelling-houses and are used for crop devastators control. In Malagassy, traditional healers prescribe the flowers decoction to treat orally splenomegaly and hepatic disorders due to malarial infection (2). It is also used in South Africa as parasiticide for cattles. *Tagetes* spp. exhale a characteristic odour due to their content in various oily and terpenic components. In fact, in previous works, it has been demonstrated that the *Tagetes* volatile oil contains carvone, linalol, limonene, ocimene, β -myrcenon, aro-maden-dron, α -terthienyl, quercetage-trin, flavonoids and phenols (12, 13, 14). Biopharmacological activity of *Tagetes minuta* volatile oil has been investigated. It has hypotensive, bronchodilatory, spasmolytic, digestive, vermifuge, cholagogue, sedative in gastric pain anti-abortifacient and anti-inflammatory activities (2, 4).

Material and Methods

1. Plant material and preparation of extract

Plant samples of *Tagetes minuta* L. (Asteraceae) were collected at Lwiro Station (Kivu province, Eastern Republic Democratic of Congo, 1750 m of altitude) in August 1993. The plant was identified by reference to the Herbarium of the Botany Laboratory and voucher specimens are preserved in the Laboratory of Medicinal Plants, Department of Biology at Lwiro, Republic Democratic of Congo.

Twenty gram of dried flowers were submitted without grinding to steam distillation (8). The volatile oil was collected under refrigeration in a glass beaker containing cold water. The supernatant oil was then exhaustively extracted with chloroform and separated from the aqueous phase by decantation. The chloroformic phase was evaporated to dryness and a yellow oily residue was obtained (yield: 5 %).

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Serial dilutions in chloroform were prepared: 100, 75, 50, 25, 10, 5 and 1 mg/ml, afterwards chloroform was evaporated by a spin dryer

2. Evaluation of the anophelinocidal activity

Adult female mosquitoes of both malaria vector species (*A. gambiae* and *A. funestus*) were collected early in the morning between 5 and 6 H inside the dwelling houses under torch light at Lwiro Station. The identification of specimen was made by one of the authors (K. B.) by referring to the entomological collection of the Medical Entomology Laboratory where voucher specimens are preserved at Lwiro.

Transparent cylindrical tubes of 125 mm in length and 44 mm in diameter (WHO label) were used for exposure (15). Fifteen adult mosquitoes were exposed into such a tube where was set out a piece of Schleicher & Schull filter paper n° 589 (30 cm²) impregnated with the prepared dose. The exposure time was one hour and afterwards mosquitoes were transferred to another tube containing a not impregnated paper and kept during 24 hours for observation in a shaded place. Mosquitoes were fed on a cotton saturated with sweetened water. Mortality counts were done at the end of the observation time and affected mosquitoes unable to walk were taken into account as recommended by WHO's procedure (15). Each test was repeated four times with a control test using a tube where impregnated paper was replaced by a sheet of clean filter paper. When control mortality rate was ranged between 5 and 20 %, the percentage of test mortality was corrected by Abbott's formula (11).

% Mortality

$$\text{corrected} = \frac{\% \text{ test mortality} - \% \text{ control mortality}}{100 - \% \text{ control mortality}} \times 100$$

Test for which the mortality rate was more than 20 % was omitted and the test re-evaluated.

Results and Discussion

Anophelinocidal activity of the volatile oil extracted from *Tagetes minuta* flowers are shown in Table 1. The volatile oil obtained by steam distillation has a real killing effect on adult mosquitoes caught inside the dwelling houses (*A. gambiae* and *A. funestus*).

The LD90, LD50 and LDOO are respectively 75 mg, 45.6 mg and 5 mg/ml. The LD50 was calculated by the regression line $Y = 11.45x + 2.92$, established by the results obtained after exposure. Trials in the laboratory conditions are in progress to evaluate the degree of the volatile oil, to determine the lethal dose depending - time, to isolate and to purify the active principles. However, in the nearest future it is intended to propose ointments and serpentine smoke producing devices from oil of the studied plant with aim at protecting people against mosquito stings.

**Table 1 : Effect of *Tagetes minuta* volatile oil on anophelins
Mortality rate after one hour exposure
and 24 hours of recovery time.**

Concentration mg/ml	Test mortality rate	Control mortality rate	Corrected test mortality rate
1	6.67	8.33	0.00
5	10.00	8.33	1.82
10	18.33	10.00	9.26
25	18.33	10.00	9.26
30	36.67	18.33	22.46
40	56.67	15.00	49.02
50	81.67	13.33	78.93
75	88.33	3.33	88.33
100	100.00	10.00	100.00

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Contribution à l'élaboration d'un nouveau programme de protection phytosanitaire du cotonnier au Burundi

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Keywords : Cotton - Pest - Pesticide - Active ingredient - Low volume spraying - Burundi.

Résumé

Les pertes de récolte causées par les ravageurs du cotonnier au Burundi constituent une contrainte majeure pour les paysans. Pendant la phase floraison-fructification, cinq à six traitements insecticides, débutant entre le 45^{ème} et le 60^{ème} jour après le semis, suivant les seuils d'infestations et espacés de deux semaines, sont préconisés pour combattre les principaux d'entre eux, les piqueurs-suceurs, les acariens et les chenilles de la capsule. Le choix des matières actives est conditionné par leur efficacité selon les déprédateurs présents, les possibilités d'interaction entre elles et la préservation de l'environnement. La présence de chenilles endocarpiques, pour lesquelles des comptages ne sont pas aisément réalisables, nécessite des interventions sur calendrier. Le nouveau programme de protection phytosanitaire du cotonnier évolue dans plusieurs domaines : l'usage de doses réduites et la diminution des coûts, l'alternance des substances actives ainsi que l'utilisation du « très bas volume » à 10 litres par hectare d'une émulsion à l'eau.

Summary

Yield losses caused by cotton pests are a major constraint for farmers in Burundi. During the flowering and fruit formation, 5 or 6 insecticide treatments are applied between the 45th and the 60th day after sowing, according to the infestation level. These treatments are carried out every two weeks against the main pests, i.e. sucking insects, mites and bollworms. The choice of active ingredients is determined by their efficacy, potential interaction and low toxicity to the environment. The presence of endocarpic bollworms, which are difficult to count requires scheduled spraying. The new cotton protection programme recommends the use of low doses of insecticides, the alternation of active ingredients and the application of water-based emulsions by low volume (10 l. per hectare).

Introduction

L'expérimentation et la mise au point des nouveaux programmes de protection phytosanitaire du cotonnier au Burundi ont comme finalité plusieurs objectifs. Le premier d'entre eux consiste à diminuer les quantités de pesticides épandues, de manière à réduire les coûts de production des paysans, tout en maintenant un haut niveau de protection contre les principaux ravageurs. En effet, en Afrique centrale, les moyens de lutte chimique restent indispensables, lorsque l'on sait que les pertes de récolte causées par les déprédateurs peuvent atteindre 30 à 50 % de potentiel de production (1,10).

En second lieu, le respect de l'environnement, ainsi que l'apparition récente d'une législation phytosanitaire au Burundi, imposent dorénavant aux responsables de la recherche l'utilisation de pesticides moins polluants pour le milieu ambiant. Pour l'homologation d'une matière active, l'efficacité vis-à-vis d'un ou de plusieurs ravageurs est à considérer, mais l'aspect nuisance sur l'environnement et en particulier sur la faune auxiliaire ainsi que la toxicité envers l'homme et les vertébrés sont aussi importants. L'apparition éventuelle de résistances de certains déprédateurs aux insecticides impose une sélection adaptée et fiable

des substances actives. Enfin, les efforts de recherche vers des matières actives sélectives et très efficaces ne seront valorisés que si les techniques permettant leur application sont performantes et à la portée des agriculteurs (6).

Au Burundi, des applications foliaires d'insecticides sont préconisées par la filière à partir du 45^{ème} au 60^{ème} jour après le semis, suivant les seuils d'infestation. La fréquence est d'un traitement insecticide toutes les deux semaines, correspondant à la phase floraison-fructification de la culture. Généralement, les quatre premiers traitements (les six premiers au Moso, le cycle du cotonnier étant allongé) sont réalisés avec des composés binaires (organo-phosphoré ou carbamate + pyréthrianoïde), tandis que les deux derniers font appel à un pyréthrianoïde seul.

Compte tenu des difficultés rencontrées ces dernières années pour le contrôle des piqueurs-suceurs (*Aphis gossypii* Glov., *Lygus vosseleri* Popp.) et des acariens, (*Polyphagotarsonemus latus* Banks, *Tetranychus* spp.) avec la technique en ultra bas volume (U.B.V. ou U.L.V.) à 2,5 l/ha en formulation huileuse déjà dosée et prête à l'emploi, technique contrôlant mal ces rava-

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geurs dans les parties moyennes et basses des cotonniers, l'adoption de volumes d'applications plus importants avec des formulations en émulsion concentrée est à l'étude au Burundi depuis 1992.

Au Moso, cette technique est utilisée depuis deux ans dans les nouvelles extensions cotonnières, tandis que dans l'Imbo, l'ancien matériel en U.L.V. est modifié et adapté à la pulvérisation « très bas volume » (T.B.V.), le volume à épandre étant fixé à 10 litres par hectare d'une émulsion à l'eau.

Parmi les ravageurs les plus nuisibles présents sur cotonniers au Burundi, outre les piqueurs-suceurs et les acariens, figurent les chenilles de la capsule à régime exocarpique, chenilles perforant la capsule, mais vivant à l'extérieur (*Helicoverpa armigera* Hb., *Earias insulana* Boisd. et *E. biplaga* Wik.) et les chenilles à régime endocarpique, chenilles vivant à l'intérieur de la capsule (*Pectinophora gossypiella* Saund., *Cryptophlebia leucotreta* Meyr.). Les dégâts causés par les chenilles phyllophages (*Syllepta derogata* Fab., *Spodoptera littoralis* Boisd.) ainsi que la mineuse du feuillage (*Acrocercops bifasciata* Wlsm.) sont nettement moins importants et souvent assez localisés. Des hétéroptères, tels que *Dysdercus* spp. n'apparaissent en grand nombre que lors de l'arrêt des applications d'insecticides en fin de campagne et sont généralement peu nuisibles (1).

Pendant les années 1992, 1993 et 1994, une expérimentation a été menée dans l'Imbo au Burundi pour la mise au point des nouveaux programmes de protection phytosanitaire du cotonnier (5). En présence de plusieurs ravageurs, ce qui est le cas le plus fréquent, le choix des matières actives et la décision de traiter est plus complexe. Elle fait appel à la fois à la notion de seuil d'intervention simple ou multiple, au choix des pesticides et à l'alternance de ceux-ci vis-à-vis des ravageurs présents

Matériel et méthodes

Choix des matières actives

Le choix des matières actives se fait en fonction des cibles bien définies. Les principaux groupes de ravageurs sont constitués par les homoptères, les hétéroptères, les acariens, les lépidoptères carphophages et les lépidoptères phyllophages. Deux grandes catégories de produits sont testées :

- les matières actives efficaces sur les homoptères-hétéroptères (organo-phosphorés et carbamates) dont les infestations peuvent être très précoces, groupe de ravageurs auquel il faut joindre les acariens, surtout les tarsonèmes et éventuellement les chenilles phyllophages.
- les matières actives efficaces sur les chenilles de la capsule (pyréthrinoides).

Les essais ont été réalisés dans l'Imbo centre, à Kabezi, pendant les campagnes cotonnières 1992, 1993 et 1994. Cette région située le long du lac Tanganyika a été choisie en fonction de la forte pression parasitaire qui y règne généralement (1).

Dispositif expérimental

Tous les essais ont été installés suivant un dispositif expérimental en blocs de Fisher avec 4 à 6 répétitions. Les semis sont réalisés à la mi-janvier avec la variété PAN 575. Les parcelles élémentaires sont constituées de 6 lignes de 15 mètres, dont les 4 lignes centrales seules sont traitées. Les deux lignes extérieures de chaque parcelle ne reçoivent aucun traitement. Le nombre de traitements insecticides est généralement de 5 ou 6 à deux semaines d'intervalle. Leur application se réalise avec des appareils à dos à pression entretenue équipés d'une rampe horizontale de 1,25 mètre pour le traitement de deux lignes de cotonniers par passage. Le volume épandu est de 200 litres de bouillie par hectare. Tous les essais sont menés jusqu'à la récolte, la première s'effectuant à la mi-juin, la seconde en juillet. Les parcelles d'essais sont fumées, désherbées et buttées.

Observations et mesures

LES PIQUEURS-SUCEURS

Aphis gossypii

Les colonies de pucerons se développent sur bourgeons, pétioles et à la face inférieure des feuilles. Ils provoquent des dégâts par leurs ponctions répétées des limbes et injection de salive toxique qui affaiblit la plante et induisent une crispation du feuillage. Les pourcentages d'infestation sont déterminés sept jours après les traitements, en observant la face inférieure de 5 feuilles terminales par plant, sur 20 cotonniers par objet. Lorsque les infestations sont importantes et précoces, comme en 1993 et 1994, un échantillonnage des plants présentant les symptômes de « feuilles crispées » est également réalisé.

Lygus vosseleri et autres Mirides

Les larves et adultes de ces petits hétéroptères se nourrissent de la sève des jeunes cotonniers en piquant les organes jeunes : bourgeons, feuilles, boutons floraux et parfois jeunes capsules. Sur bourgeons et jeunes feuilles, ces nombreuses piqûres provoquent des nécroses locales qui se manifestent lors de l'étalement des feuilles par des déchirures irrégulières du limbe et sur les jeunes organes, par leur chute. Les échantillonnages sont réalisés sept jours après les traitements sur 20 plants par parcelle, présentant les symptômes typiques de déformation du feuillage (frisolée).

LES ACARIENS

Polyphagotarsonemus latus

Les piqûres répétées des tarsonèmes sur la face inférieure des feuilles induisent une coloration argentée avec les nervures en relief. La face supérieure du limbe devient vert sombre, se creuse légèrement, et ses bords s'enroulent vers le bas. Plus tard, les feuilles se déchirent irrégulièrement (2). L'échantillonnage des plants présentant les symptômes typiques de l'acariose sur les trois dernières feuilles de la tige principale est effectué sur 20 plants par objet, une

semaine après les traitements. En 1992, un échantillonnage des formes mobiles a été réalisé dans un champ de binoculaire sur une feuille prélevée au sommet de dix cotonniers par objet.

Tetranychus spp.

Les tétranyques font leur apparition sur les cotonniers vers avril-mai, où leur présence sur le feuillage provoque une coloration brunâtre de la face supérieure des limbes. En général, les infestations demeurent limitées, sauf en 1992 où celles-ci furent plus importantes. La présence efficace d'un thrips prédateur de l'acarien rouge, *Scolothrips sexmaculatus* Perg. entraîne une diminution rapide et importante des populations.

LES CHENILLES CARPOPHAGES

Shedding parasitaire pré et post floral

Il consiste à dénombrer une fois par semaine sur deux interlignes par parcelle, l'abscission des boutons floraux et des jeunes capsules avec perforations dues aux chenilles exocarpiques (*Helicoverpa armigera* et *Earias spp.*). En complément, des observations sur la présence de chenilles sur les boutons floraux, fleurs et capsules sur 20 cotonniers par objet peuvent être réalisées toutes les deux semaines.

Analyse sanitaire des capsules vertes et des capsules à maturité

Des échantillonnages sont effectués sur 50 capsules vertes de 3 à 4 centimètres de long prélevées au hasard sur 2 x 25 cotonniers des lignes 2 et 5 de chaque parcelle. Avant la première récolte, 100 capsules ouvertes parvenues à maturité sont également prélevées suivant les mêmes modalités. Après ouverture des capsules vertes au laboratoire, on détermine le nombre de capsules trouées par *H. armigera* et

Earias spp., ou parasitées par *Pectinophora gossypiella* et *Cryptophlebia leucotreta* ainsi qu'éventuellement, le nombre de capsules bactériosées par *Xanthomonas campestris* pv. *malvacearum* Sm. (2) ou atteintes de stigmatomycose ou pourriture des capsules due aux *Nematospora spp* (10). Les capsules parvenues à maturité sont triées comme les capsules vertes, la récolte de coton graine faisant l'objet d'un triage et d'une pesée.

Récolte: la récolte du coton graine est réalisée sur les deux lignes centrales de chaque parcelle élémentaire et l'estimation du rendement est effectuée après triage et pesée de la récolte en deux catégories : coton blanc et coton jaune (seconde qualité).

Analyses statistiques des données

Les essais en dispositif statistique sont analysés après transformation arc sinus racine carrée pour les proportions et les pourcentages, racine carrée de $x+1$ ou logarithme ($x+1$) pour les dénombrements des populations dans le but d'homogénéiser les variances, selon le « multiple range test » de Newman-Keuls et éventuellement le test de Dunnet. Les objets qui ne diffèrent pas statistiquement entre eux au seuil de 0,05 sont affectés d'une même lettre.

Résultats

Les piqueurs-suceurs

Aphis gossypii : En 1992, 10 matières actives ont été comparées entre elles et à un témoin non traité. Six applications foliaires d'insecticides à un intervalle de deux semaines ont été réalisées à partir du 43^{ème} jour après le semis. Les résultats moyens des cinq observations sur les pucerons effectués entre mars et mai sont repris dans le tableau 1.

**Tableau 1 : 1992 - Pourcentages d'infestation par *Aphis gossypii*
Test de Newman-Keuls et test de Dunnet - Seuil 5 % (4 répétitions)**

Facteur traitement croisé avec les blocs hiérarchisés au facteur dates de comptage

Traitements ⁽¹⁾	Moyennes	Gr. hom.	Test de DUNNET Moyennes
1. Témoin non traité	13,55	a	13,55 = Témoin
2. Profenophos 300 g/ha	12,25	a b	12,25
3. Chlorpyrifos-éthyle 300 g/ha	11,88	a b	11,88
4. Pyridaphenthion 400 g/ha	11,23	a b	11,23
5. Chlorpyrifos-méthyle 300	11,05	a b	11,05
6. Diméthoate 300 g/ha	10,70	a b c	10,70
7. Isoxathion 250 g/ha	9,75	a b c	9,75 < Témoin
8. Imidaclopride 100 g/ha	9,40	b c d	9,40
9. Chlorpyrifos-méthyle 500	8,70	b c d	8,70
10. Carbosulfan 300 g/ha	8,38	c d	8,38
11. Benfuracarbe 300 g/ha	8,05	c d	8,05
12. Monocrotophos 250 g/ha	6,75	d	6,75
C.V. en %	40,5		
Probabilité	***		
Transform. Statistique	arc sinus \sqrt{x}		
C.V. transformé en %	20,7		

*** : Différences significatives pour $\alpha \leq 0,001$ $P \geq 99,9\%$

Les nombres suivis d'une même lettre ne diffèrent pas de façon significative

Gr. hom. : groupe homogène

⁽¹⁾ Deltaméthrine à 10 g/ha en traitement de couverture

Le benfuracarbe, le carbosulfan, le chlorpyrifos-méthyle à 500 g/ha et l'imidaclopride suivis de l'isoxathion sont les produits les plus efficaces pour assurer le contrôle d'*Aphis gossypii*. Ces aphicides peuvent remplacer le monocrotophos jugé actuellement trop polluant pour l'environnement.

En 1993 et 1994, contrairement à l'essai de 1992, les 4 traitements aphicides et acaricides ont été appliqués en alternance, en complément à un pyréthrianoïde, ce qui semble être la meilleure manière de contrôler simultanément les populations de pucerons et d'acariens.

En 1993, les résultats positifs enregistrés l'année précédente ont été confirmés pour les mêmes matières actives. Pour l'expérimentation effectuée en 1994, d'autres aphicides en application foliaire ont été testés avec succès, comme l'oxydéméton-méthyle à 500 g/ha, l'ométhoate à 250 g/ha ainsi que l'imidaclopride à 50 g/ha et le diméthoate à 400 g/ha. Les résultats complets figurent dans le tableau 3.

Les semences utilisées pour l'essai de 1994 ont été délintées et traitées avec imidaclopride 70 % à 17,16 g P.C./kg + chlorothalonil 50 % à 1,6 g P.C./kg (4). Le développement des populations de pucerons fut très précoce. En effet, pour le témoin, on enregistre déjà 29 jours après le semis, pratiquement 100 % des jeunes cotonniers présentant les symptômes des feuilles crispées. Cette population restera très élevée pendant les trois premiers mois de végétation (Figure 1). Pour le traitement de semences effectué avec imidaclopride + chlorothalonil, les pourcentages d'infestation restent très bas (maximum : 14,2 % à 29 J) et n'induisent que 2 % des plants avec des feuilles crispées. L'effet résiduel du traitement de semences sur *Aphis gossypii* atteignant plus de 60 jours, la première application foliaire a été réalisée avec un acaricide + insecticide, le seuil d'intervention étant atteint pour les tarsonèmes. Après ce premier traitement foliaire acaricide-insecticide suivi d'une application aphicide-insecticide les populations de pucerons demeurent extrêmement faibles. Par contre, pour l'objet sans traitement foliaire, les populations d'*Aphis gossypii* augmentent à nouveau d'une façon significative par rapport aux objets qui reçurent un traitement foliaire acaricide, puis aphicide (Figure 1).

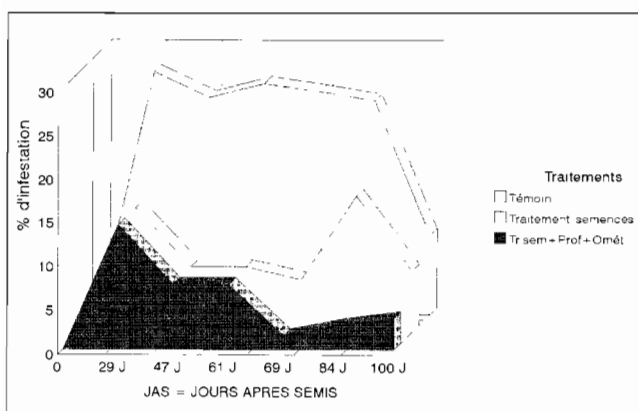


Figure 1 : 1994 : Pourcentages d'infestation par *A. gossypii* pour le témoin, le traitement de semences et le tr. de semences + tr. foliaire acaricide + tr. foliaire aphicide

La dynamique des infestations par les pucerons est reprise à la Figure 1 pour le témoin non traité, le traitement de semences et le traitement de semences suivi, à partir du 61^{ème} jour, d'un traitement foliaire profénophos + lambdacyhalothrine, puis deux semaines plus tard d'une application d'ométhoate + lambdacyhalothrine.

En conclusion, le traitement des semences délintées avec imidaclopride + chlorothalonil a permis d'assurer une excellente maîtrise des infestations précoces des pucerons. L'alternance des traitements aphicides sur semences, acaricides foliaires puis aphicides foliaires a maintenu les populations d'*A. gossypii* à un niveau d'infestation particulièrement bas.

Lygus vosseleri et autres Mirides

Des observations ont été réalisées en 1993 et 1994 sur les dégâts provoqués au bouquet foliaire terminal des cotonniers par les Mirides. A Kabezi, les attaques demeurent faibles et dépassent rarement 25 % des plants présentant les symptômes de la « frisolée ». Après la réalisation du premier traitement foliaire aphicide + pyréthrianoïde en 1993 et acaricide + pyréthrianoïde en 1994, les pourcentages d'infestation ne dépassent pas 5 % dans les objets traités et après l'application du second traitement, les symptômes disparaissent totalement. Dans l'Imbo, les populations de Mirides sont totalement maîtrisées après les deux premières interventions. Par contre, au Moso, les infestations sont plus importantes et semblent plus difficiles à combattre, lorsqu'on emploie un carbamate ou un organo-phosphoré seul, sans adjonction d'un pyréthrianoïde (traitement d'alerte avant les applications sur calendrier), comme cela a déjà été mis en évidence au sud du Zaïre (9). Dans le tableau 3, sont repris les principaux résultats des matières actives testées durant trois années à Kabezi sur les insectes piqueurs-suceurs et sur *Polyphagotarsonemus latus*.

Les acariens:

Polyphagotarsonemus latus

En général, dans certaines régions de l'Imbo et notamment dans la plaine de Kabezi, les infestations dues aux tarsonèmes sont très précoces. Elles apparaissent vers la fin février, début mars. Par ailleurs, l'apparition des pucerons précède généralement de quelques semaines celle des acariens verts. L'application de certains aphicides permet de freiner le développement des populations d'acariens, par contre, d'autres matières actives ne semblent posséder qu'une faible voire aucune efficacité (11). Pour l'essai aphicide-acaricide réalisé en 1992, les résultats de 2 échantillonnages des plants présentant les symptômes de l'acariose sont repris dans le tableau 2. Le chlorpyrifos-éthyle à 300 g/ha et l'isoxathion à 250 g/ha se sont montrés les produits les plus efficaces pour le contrôle des tarsonèmes. Ils sont suivis par le profénophos à 300 g/ha et le pyridaphenthion à 400 g/ha. Les autres matières actives testées sont peu efficaces ou sont inefficaces aux doses testées. Ces observations des symptômes de l'acariose sur feuilles de cotonniers confirment les résultats obtenus par le dénombrement des acariens au binoculaire.

Tableau 2 : 1992 - Pourcentages de cotonniers acariosés
Comparaisons multiples des moyennes (4 répétitions) Test de Newman-Keuls - Seuil 5 %

Dates d'observations Objets	27.4.92			19.5.92		
	Moy.	Gr. hom.		Moy.	Gr. hom.	
1. Imidaclopride 100 g/ha	100	a		100	a	
2. Diméthoate 300 g/ha	100	a		100	a	
3. Monocrotophos 250 g/ha	100	a		100	a	
4. Témoin	100	a		98	a	
5. Benfuracarbe 300 g/ha	95	a		83	a b	
6. Carbosulfan 300 g/ha	83	a		85	a b	
7. Chlorpyriphos-méthyle 300	83	a		83	a b	
8. Chlorpyriphos-méthyle 500	80	a		98	a	
9. Pyridaphenthion 400 g/ha	55	a		58	a b	
10. Profénophos 300 g/ha	40	a	b	50	b	c
11. Isoxathion 250 g/ha	28		b c	35		c
12. Chlorpyriphos-éthyle 300g/ha	10		c	25		c
C.V. en %		32,3			28,4	
Probabilité		***			***	
Transform. Statist.		arc sin \sqrt{x}			arc sin \sqrt{x}	
C.V. transformé en %		22,5			16,6	

***: Différences significatives pour $\alpha \leq 0,001$ $P \geq 99,9$ %

Les nombres suivis d'une même lettre ne diffèrent pas de façon significative.

Pour l'essai réalisé en 1993, les deux traitements aphicides alternent à deux semaines d'intervalle avec les deux traitements acaricides, sauf pour le traitement au pyridaphenthion. Seules, les associations comprenant du diméthoate et de l'imidaclopride se sont révélées insuffisantes pour assurer un contrôle efficace de *P. latus*. Il n'est donc pas recommandé d'utiliser ces deux aphicides en application foliaire lorsque la présence des acariens est importante.

En présence de populations abondantes de tarsonèmes, la stratégie de lutte consiste à alterner les aphicides et les acaricides, en utilisant les produits les plus

performants et en employant de préférence des aphicides qui freinent le développement des acariens entre deux applications d'acaricides, qui sont espacées d'une trentaine de jours. Les résultats complets des matières actives expérimentées figurent au tableau 3.

Les chenilles de la capsule

Shedding parasitaire pré et post floral et prélèvement de capsules vertes et à maturité

L'abscission des boutons floraux débute en général début avril, suivi de celle des jeunes capsules, avec

Tableau 3 : Efficacité des aphicides et des acaricides testés en 1992, 1993 et 1994 sur les piqueurs-suceurs et les tarsonèmes

Matières actives	Doses g/ha	Efficacité sur <i>Mirides</i> (1)	Efficacité sur <i>Aphis gossypii</i>	Efficacité sur <i>Polyphagotarsonemus latus</i>
1. Carbamates systémiques				
Benfuracarbe	240	**	***	*
Benturacarbe	300	***	***	*
Carbosulfan	300	***	***	*
2. Nitro-méthylènes systémiques				
Imidaclopride	50	*	***	-
Imidaclopride	100	*	***	-
3. Organo-phosphorés systémiques				
Diméthoate	300	-	*	-
Diméthoate	400	(?)	***	-
(Monocrotophos)	250	0	***	*
Ométhoate	250	(?)	***	*
Oxydéméton-méthyle	500	(?)	***	*
4. Organo-phosphorés non systémiques				
Chlorpyriphos-éthyle	300	0	*	***
Chlorpyriphos-méthyle	300	0	*	*
Chlorpyriphos-méthyle	500	**	***	*
Isoxathion	250	0	**	***
Pyridaphenthion	400	0	*	**
Pyridaphenthion	500	**	*	***
Triazophos	250	0	*	***
Profénophos	250	0	*	*
Profénophos	300	0	*	**
Profénophos	350	0	*	**
Profénophos	400	0	*	***

* Faible efficacité **Efficacité moyenne *** Très efficace

- Sans intérêt 0 Non testé (?) A préciser

(1) L'estimation de l'efficacité sur les *Mirides* est également fonction des autres matières utilisées dans les formules binaires et notamment de celle des pyréthrinoides. En 1994 (?), les infestations furent insuffisantes.

un pic fin avril pour se terminer vers la fin mai, après l'arrêt des pluies. Le maximum de shedding parasitaire correspond au maximum des populations des chenilles dénombrées dans les témoins. Les résultats de l'abscission des organes fructifères à l'are figurent dans le tableau 4 pour l'expérimentation effectuée en 1994, ainsi que l'analyse sanitaire des capsules vertes et des capsules parvenues à maturité.

Pour l'expérimentation effectuée en 1994, toutes les matières actives testées, dont certaines à deux doses,

18 g/ha, esfenvalerate : 20 g/ha, tralométhrine : 12 g/ha, bifenthrine : 25 g/ha, cyfluthrine : (16) et 18 g/ha, lambdacyhalothrine : (12) et 15 g/ha, zétacyperméthrine : (12) et 15 g/ha. Les doses entre parenthèses, testées uniquement en 1994, constituent des doses minima à employer en association binaire avec un aphicide ou un acaricide, application toutes les deux semaines. L'éthofenprox, substance active pratiquement sans toxicité, et qui a été testé en 1992 et 1993 à 200 g/ha en association binaire et à 300 g/ha seul, s'est révélé un peu faible pour la maîtrise des

Tableau 4 : 1994 - Shedding parasitaire des boutons floraux et des petites capsules à l'are et analyse des capsules vertes et des capsules à maturité en %.

Facteur traitement croisé avec les blocs hiérarchisés au facteur dates de comptage (shedding : 7 observations)

Matières actives	Abcission des organes troués à l'are				Capsules saines en %			
	Boutons		Capsules		Vertes		Mûres	
	Moy.	Gr.hom	Moy.	Gr.hom	Moy.	Gr.hom	Moy.	Gr.hom
1.Témoin non traité	69,21	a	66,88	a	74,0	b	89,3	b
2.Zétacyperméthrine 12 g/ha	14,00	b	13,83	b	94,0	a	97,8	a
3.Lambdacyhalothrine 12 g/ha	12,04	b c	10,25	b	95,0	a	96,5	a
4 Zétacyperméthrine 15 g/ha	10,25	b c d	9,83	b	91,0	a	98,0	a
5.Bifenthrine 25 g/ha	9,96	b c d	11,00	b	92,0	a	97,8	a
6.Cyfluthrine 16 g/ha	7,46	b c d	9,21	b	94,0	a	94,3	a
7.Cyfluthrine 18 g/ha	6,25	c d	8,04	b	97,5	a	98,7	a
8.Lambdacyhalothrine 15 g/ha	4,63	d	6,54	b	91,5	a	99,5	a
Probabilité	***		***		***		**	
CV en %	91,50		68,60		5,7		3,0	
Transformation statistique	$\sqrt{x+1}$		$\sqrt{x+1}$		-		-	
CV transformé en %	26,70		22,60		-		-	

*** : Différences significatives pour $\alpha \leq 0,001$ $P \geq 99,9$ %

** : Différences significatives pour $\alpha \leq 0,01$ $P \geq 99$ %

Les nombres suivis d'une même lettre ne diffèrent pas de façon significative

ont montré une efficacité similaire à celle de la cyfluthrine, substance active prise comme référence, aussi bien pour le shedding parasitaire des boutons floraux et des petites capsules que pour l'analyse sanitaire des grosses capsules. Dans le témoin non traité, un quart des grosses capsules vertes a présenté soit des perforations causées par les chenilles à régime exocarpique, ou était parasité par des chenilles à régime endocarpique, soit était atteint de pourriture (stigmatomycose et bactériose). Pour les capsules mûres, on relève dans le témoin, 10,7 % de capsules attaquées, dont 5,3 % parasitées par *Pectinophora gossypiella* et *Cryptophlebia leucotreta*. Ce taux de parasitisme de 5 % environ pour les chenilles endocarpiques est pratiquement le même que celui enregistré en 1992 et 1993. Parmi les ravageurs des organes fructifères, *Helicoverpa armigera* est actuellement et reste le ravageur le plus dangereux au Burundi (1).

En conclusion, les matières actives expérimentées en 1992, 1993 et 1994 dans l'Imbo ont permis d'assurer un contrôle très satisfaisant des ravageurs des organes fructifères du cotonnier. Les pyréthrinoides suivants, en association binaire ou utilisés seuls lors des deux derniers traitements, ont permis d'obtenir une excellente efficacité sur les chenilles de la capsule : deltaméthrine : 10 g/ha, alphacyperméthrine :

chenilles carpophages. Dès les premières applications la dose de 300 g/ha serait plus appropriée.

Rendement à la récolte

Un exemple de récolte pour l'année 1993 figure au tableau 5.

Les traitements binaires aphicides-insecticides, suivis d'acaricides-insecticides, en alternance pour les quatre premières applications, suivis de deux traitements aux pyréthrinoides seuls, autorisent dans ce cas, des augmentations de récolte de plus de 400 à 700 kg/ha de coton graine par rapport à un témoin sans protection chimique. Les pourcentages de coton jaune de seconde qualité varient généralement pour les parcelles traitées de 1 à 5 %. Ils sont plus élevés en 1993, à cause d'une infestation tardive due à la bactériose capsulaire. Dans les objets sans protection chimique, ils varient de 5 à 10 % environ.

Discussion

La protection phytosanitaire du cotonnier dans la région de l'Imbo fait appel à 4 à 6 traitements à « ultra bas volume » (U.B.V.) à 2,5 litres par hectare, programmée suivant un calendrier préétabli. Le premier

**Tableau 5 :1993 - Rendement en coton-graine en kg/ha
Comparaison multiple des moyennes - Test de Newman-Keuls (Seuil 5 %)**

Traitements	Coton blanc 1 ^{ère} récolte		Augm. rendement kg/ha	Coton blanc Récolte totale		Coton jaune Récolte totale		Augmentation rendement	
	Moy	Gr.hom		Moy.	Moy.	%	kg/ha	%	
1.Esfenvalérate+benfuracarbe/isoxathion	1706,3	a	667,1	2140,3	67,1	3,0	706,1	49,2	
2.Tralométhrine+carbosulfan/chlorpyriphos-éthyle	1692,5	a	653,3	2121,5	75,7	3,5	687,3	47,9	
3.Fenvalérate+benfuracarbe/triazophos	1668,8	a	629,6	2131,6	54,8	2,5	697,4	48,6	
4.Deltaméthrine+chlorpyriphos-méthyle/triazophos	1636,2	a	597,0	2143,4	74,7	3,4	709,2	49,4	
5.Ethofenprox/pyridaphenthion	1549,7	a	510,5	2131,2	102,8	4,6	697,0	48,6	
6.Cyfluthrine+imidachlopride/chlorpyriphos-éthyle	1508,5	a	469,3	2042,7	119,2	5,5	608,5	42,4	
7.Alphacyperméthrine+diméthoate/profénophos	1439,3	a	400,1	1897,0	85,5	4,3	462,8	32,3	
8. Témoin non traité	1039,2	b	-	1434,2	136,7	8,7	-	-	
	Probabilité	**		NS		NS			
	CV en %	12,6		15,6		47,3			

** Différences significatives pour $\alpha \leq 0,01$ $P \geq 99$

NS Non significatif

Les nombres suivis d'une même lettre ne diffèrent pas de façon significative

traitement a lieu entre le 45^{ème} et le 60^{ème} jour après le semis et les applications se suivent de 14 jours. Afin de rationaliser l'emploi des insecticides, ce programme standard a été amélioré en fonction du complexe parasitaire et de l'évolution des techniques d'application, en diminuant les doses de matières actives dans un souci de rentabilité pour le producteur, de protection de l'environnement et de la faune utile. A partir de 1995, les champs de cotonniers sont traités « à très bas volume » (TBV) avec des concentrés émulsionnables dans l'eau à raison de 10 litres de bouillie par hectare, qui assurent un meilleur recouvrement des cotonniers. Les émulsions concentrées présentent l'avantage d'être moins chères de 25 à 30 % pour une même quantité de matières actives épandues (7) et offrent la possibilité de les séparer et de moduler les doses épandues en fonction des ravageurs dominants de chaque région écologique (10).

La décision de traiter est liée au dépassement d'un seuil. Pour les insectes piqueurs-suceurs, les seuils d'infestation déterminent souvent la date d'intervention entre le 45^{ème} et le 60^{ème} jour après le semis. Les traitements se réalisent alors toutes les deux semaines, en fonction du parasitisme présent. En traitement foliaire contre les pucerons, les matières actives testées aux doses préconisées obtiennent une excellente efficacité : benfuracarbe, carbosulfan, chlorpyriphos-méthyle, diméthoate, imidaclopride, ométhoate et oxydéméton-méthyle. Elles complètent ou remplacent des aphicides plus anciens. Une alternative au premier traitement foliaire dirigé contre *A. gossypii*, consiste à réaliser un traitement des semences avec imidaclopride + chlorothalonil qui permet une maîtrise des populations de pucerons pendant deux mois après le semis tout en améliorant la lutte contre la fonte des semis (4). Toutefois, le coût de ce traitement reste actuellement assez onéreux.

Pour combattre les acariens verts, le chlorpyriphos-éthyle, l'isoxathion ainsi que le pyridaphenthion complètent les matières actives utilisées précédemment (profénophos, triazophos). Ces acaricides, en traitement binaire avec un pyréthrinolide, s'utilisent alterna-

tivement avec les aphicides lors des quatre premiers traitements.

Pendant la phase floraison-fructification, il est par conséquent indispensable de traiter avec des associations binaires aphicide ou acaricide auxquelles on joint un pyréthrinolide. Une synergie peut se manifester entre certains produits qui se traduit par une efficacité supérieure du mélange des deux produits en comparaison de la somme d'activité séparée de ceux-ci. Ce phénomène peut contribuer à la prévention de résistance à l'égard d'une matière active ou d'une famille chimique, car les sites d'action des deux substances actives utilisées sont distincts (6).

Concernant l'appareil fructifère, *Helicoverpa armigera* demeure actuellement le ravageur le plus dommageable. Cela n'a cependant pas toujours été le cas, *Pectinophora gossypiella* et *Cryptophlebia leucotreta* ont parfois été nettement plus nuisibles dans certaines régions (1) (3). Plus d'une demi-douzaine de substances actives ont été mises au point pour combattre efficacement aussi bien les chenilles à régime exophage qu'endophage, à des doses par hectare de 10 à 25 g (alphacyperméthrine, bifenthrine, cyfluthrine, deltaméthrine, esfenvalérate, lambdacyhalothrine, tralométhrine et zétacyperméthrine). Elles complètent ou remplacent les pyréthrinolides de premières génération utilisées à des doses plus importantes (cyperméthrine, deltaméthrine et fenvalérate).

Au Burundi, où la présence de chenilles à régime endocarpique est une constante du parasitisme et pour lesquelles les infestations ne sont pas aisément comptabilisées sans prélèvement de capsules dans les champs, des applications sur calendrier restent conseillées pour la lutte contre ce type de ravageurs, notamment pour les deux ou trois derniers traitements foliaires.

Pour les orientations futures des programmes de lutte, qui intègrent progressivement la notion de seuils économiques d'intervention (6), plusieurs objectifs restent à confirmer. Citons parmi ceux-ci, la poursuite de l'expérimentation des traitements de semences dirigés contre les pucerons, couplés aux traitements foliaires,

ainsi que l'exploitation du phénomène de synergie de certains organo-phosphorés lorsqu'ils sont associés aux pyrèthrinoides. Dans un autre domaine, développer la recherche vers la lutte étagée ciblée, qui est un programme raisonné sur calendrier, les doses et les matières actives étant définies selon l'importance et le type de ravageurs, à partir d'observations effectuées au champ la veille du traitement (8), en l'adaptant au parasitisme du Burundi dans des programmes de protection mixte.

C'est une première étape vers l'abandon des techniques classiques et le développement d'une lutte raisonnée en fonction des seuils d'intervention.

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Evaluation of Genetic Variations and Breeding Values of Durum Wheat Lines in a Semi-Arid Environment of Tunisia

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Keywords : *Triticum* sp. - Durum wheat - Breeding - Selection.

Summary

Thirty one durum wheat lines introduced from the International Center of Agricultural Research in the Dry Areas (ICARDA) Durum Wheat Drought and Heat Tolerance Observation Nursery were investigated on main agronomic characters under the rainfed conditions of the Kef semi-arid region of Tunisia during the 1991/92 and 1992/93 growing seasons for evaluation of their genetic variations and breeding values.

All characters showed relatively large variations. Some lines performed better than the most commonly grown local cultivars included in the experiment as checks. Selection based on mean productivity defined as the average yield over the two growing seasons was applied in order to select the best genotypes. Eight elite lines were identified.

Résumé

Trente et une lignées de blé dur provenant de la Pépinière d'Observation de la Tolérance à la Chaleur et à la Sécheresse du Centre International de la Recherche Agricole dans les Régions Arides (ICARDA) ont été étudiées sous les conditions pluviales de la région tunisienne semi-aride du Kef pendant les deux campagnes agricoles de 1991/92 et 1992/93. L'objectif était d'évaluer leurs variations génétiques pour les principaux caractères agronomiques et leur valeur d'amélioration ainsi que d'effectuer une sélection basée sur la productivité moyenne définie comme le rendement moyen pendant les deux campagnes agricoles.

Tous les caractères observés ont montré de larges variations. Quelques lignées se sont comportées mieux que les variétés locales les plus couramment cultivées incluses dans l'essai en tant que témoins. Huit lignées élités ont été identifiées.

Introduction

In Tunisia, durum wheat is an important cereal crop grown under rainfed conditions in about 58% of the acreage reserved to cereals (1.2 to 1.5 million hectares). Average yields are irregular and always depend on prevailing weather conditions. Demand for wheat continues to outpace supply and will not be met unless high-yielding cultivars are grown. Identification of such cultivars is the best and most economical method for increasing wheat production. Research on cereal improvement has developed a limited number of adapted cultivars. However, modern agricultural technology demands many cultivars with satisfactory mean yields. A strategy of selection based on mean yields across seasons and sites is efficient in accounting for variability in yield and hence lowers risk and raises profit to the growers (3, 4).

A wide wheat germplasm base is the foundation of any crop improvement process and must be available in order to enhance yielding ability (2, 5). Commercially acceptable cultivars may emerge from the manipulation of introduced genetic resources. Evaluation of them is of prime importance in selecting desirable types (1).

The purpose of this study was to determine major agronomic characters of durum wheat lines introduced from the International Center for Agricultural Research in the Dry Areas (ICARDA) to Tunisia and to compare their yield potential with that of commercial cultivars grown in the Kef semi-arid area of Tunisia.

Material and Methods

Thirty one durum wheat lines (Table 1) selected from the ICARDA's Durum Wheat Drought and Heat Tolerance Observation Nursery were investigated on main agronomic characters under the rainfed conditions of the Kef semi-arid region of Tunisia during the 1991/92 and 1992/93 growing seasons for evaluation of their genetic variations and breeding potential. The lines included in the trials were initially selected at ICARDA in Aleppo, Syria, under low to moderate rainfall conditions. All entries are spring types. Before being brought to the trial, they were subjected to a seed increase process during the 1990/91 growing season at the Experiment Station of the «Ecole Supérieure d'Agriculture du Kef», Tunisia.

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Table 1
Name or Cross / Pedigree of the durum wheat lines

Entry	Name or Cross / Pedigree ^{1a}
Introduced germplasm	
01	Om rabi 5
02	Ru/Wascana ICD84-0665-6AP-TR-22AP-0TR
03	Ru/Wascana ICD84-0665-6AP-TR-26AP-0TR
04	Rufom-9 ICD84-1257-7AP-TR-2AP-0TR
05	Rufom-10 ICD84-1257-7AP-TR-3AP-0TR
06	Rufom-6 ICD84-1257-7AP-TR-5AP-0TR
07	Ru/Mrb15 ICD84-1257-7AP-TR-11AP-0TR
08	Omguer-4 ICD85-0988-6AP-TR-2AP-0TR
09	Belikh 2 L92-6AP-1AP-1AP-0AP
10	Guerou 1 ICD79-1463-1AP-2AP-4AP-0AP
11	GdoVZ 512/Cit/Ruff/Fg/3/Nile ICD86-0615-ABL-0TR-2AP-0TR
12	GdoVZ 512/Cit//Ruff/Fg/3/DWL 5023 ICD86-0838-ABL-0TR-4AP-0TR
13	Mrb3/Chen ICD85-0642-ABL-5AP-0TR-7AP-0TR
14	Mrb3/Chen ICD85-0642-ABL-28AP-0TR-2AP-0TR
15	Mrb SH/Heider ICD85-0910-ABL-2AP-0TR-12AP-0TR
16	Omtel-2 ICD-BM-ABL-405-0AP
17	Om rabi 5
18	Rusomar-1 ICD-BM-ABL-406-0AP
19	Stk/4/Jo/3/Cr//Cit 71 ICD83-0050-3AP-6AP-0TR
20	Om rabi 3 L 0589-4L-2AP-3AP-0AP
21	Stk/4/Jo/3/Jo/Cr//Cit71 ICD-BM-ABL-306-0AP
22	Chahba 88/Khb2 ICD85-0666-ABL-TR-5AP-0TR
23	Korifla
24	Khb1//BD2014/Rabi ICD85-0305-ABL-2AP-0TR
25	GdoVZ 2512/Cit//Ruff/Fg/3/Nile ICD86-0615-ABL-0TR-1AP-0TR
26	GdoVZ512/Cit//Ruff/Fg/3/GgoVZ449 ICD85-1517-ABL-1AP-0TR-4AP-0TR
27	Krf/Baladia Hamra//Krf ICD86-1753-ABL-2AP-0TR-1AP-0TR
28	Aw12/Bit ICD84-0322-ABL-5AP-TR-AP-6AP-0TR
29	Carzio (Italy)
30	Acsad 71/4/Plc/Ibis//Gta/Bit/3/Gd ACSAD 88 9-42-0AP
31	Gta/Tc60//Stk/3/Chahba 88 ICD86-1031-ABL-3AP-0TR
Local checks	
32	Chili
33	INRAT 69
34	Karim
35	Ben Bechir
36	Razzek

^{1a} All crosses are made in ICARDA, Aleppo, Syria

Annual precipitation at the experimental site has historically fluctuated between 300 mm and 500 mm with most rainfall occurring during the period 1 October to 30 April. Monthly precipitation (mm) during the two growing seasons, respectively for 1991/92 and 1992/93, was 56.5 and 19.5 in September, 52.6 and 48.7 in October, 32.6 and 59.7 in November, 16.1 and 56.4 in December, 28.4 and 21.3 in January, 62.3 and 24.9 in February, 31.1 and 45.1 in March, 95.8 and 7.3 in April, 82.1 and 44.5 in May, and 27.7 and 14.8 mm in June (a total of 485.2 and 338.2 mm). The soil at the test site is an sandy clay loam, not well developed, deep, and a fine textured vertisol. On a volume basis, it has a field capacity of 27% and a wilting point of 12%. Prior to each trial the site was a fallow. Field tillage consisted of a deep fall plowing followed by a good seed bed preparation. Fertilizers were applied at the recommended rates (based on soil test results) for optimum wheat yield. Plots were kept weed free by a periodic hand weeding.

The experimental design was a randomized complete block design with four replications. Plots were 5 m long with 6 rows spaced 20 cm apart. Seeds were drilled at a rate of 250 grains/m². At maturity, the four center rows of each plot were harvested with a Hege plot combine and yield corrected to 13% moisture.

Measurements were taken on grain yield, 1,000-kernel weight, days to heading, plant height, and leaf rust and septoria infections. The data collected for each trait was subjected to an analysis of variance. The least significant difference (LSD) value appropriate for comparing two cultivar means was computed.

Since in Tunisia moisture stress is unpredictable from year to year, selection based on mean productivity defined as the average yield over the two growing seasons was applied.

Results and Discussion

Grain yield differences among the entries were highly significant during every growing season. All entries produced more yield during the 1991/92 than during the 1992/93 growing season. The mean grain yield ranged from 2946 to 7298 kg/ha in 1991/92 and from 1502 to 3441 kg/ha in 1992/93 (Table 2). During the 1992/93 growing season, none of the introduced cultivars performed better than the cultivars Karim, Ben Bechir and Razzek (checks), the most widely grown cultivars in Tunisia (Table 2). However, during this same year, some introduced cultivars out yielded the other two checks, Chili and INRAT 69 which are grown in an important acreage in the semi-arid region of Tunisia because they are more drought tolerant than the remaining checks used in this experiment. The mean yield (pooled over the 2 years) of the introduced lines was compared to that of the checks. The lines which out yielded the mean of the checks by more than 10% were identified as high yielding lines. These lines were decreasing, yielding : No. 28, No. 08, No. 26, No. 27, No. 01, No. 22. No. 03, and No. 09. They were associated with 137%, 123%, 122%, 118%, 116%, 116%, 113%, and 112% of the overall mean seed yield of the checks, respectively. Thus, they

might have the potential of becoming varieties used in the semi-arid conditions of Tunisia or may be utilized as parents in future crosses. Despite the favorable environmental conditions, Om rabi 3 (entry No. 20), compared to the remaining introduced lines, was

associated with the minimum grain yield value in 1991/92 (Table 2). This cultivar is going to be released in Tunisia as a registered variety but from the results of this experiment it does not seem to be a desirable type in Le Kef semi-arid region of Tunisia.

Table 2
Mean of the major agronomic characters of the germplasm during the 1991/92 and 1992/93 growing seasons

Entry No.	Agronomic character*							
	1991/92				1992/93			
	SY	KW	DH	PH	SY	KW	DH	PH
01	5747	52.4	137	103	2396	44.9	139	92
02	4647	53.8	148	123	1809	46.8	151	110
03	5680	51.7	140	96	2211	50.0	141	87
04	4995	46.9	140	116	1502	43.8	144	101
05	4318	42.8	148	126	2322	39.5	149	108
06	5160	49.7	141	125	1858	43.7	143	103
07	4682	51.2	141	128	1598	41.8	140	105
08	6180	52.4	137	118	2415	46.9	140	93
09	6032	53.4	146	97	1794	44.4	144	82
10	4336	54.5	137	94	2020	50.1	141	85
11	5544	56.7	138	93	1940	48.6	141	79
12	5384	48.7	135	104	2183	44.0	133	87
13	5322	49.5	138	121	1901	44.4	140	102
14	5325	49.1	148	122	2246	42.8	151	107
15	4237	49.0	136	130	2159	43.0	135	112
16	4703	51.2	138	135	2489	43.9	142	115
17	5085	52.3	134	101	2166	47.4	139	86
18	4862	53.4	136	123	1955	46.0	139	104
19	5396	54.1	147	96	1694	47.1	146	83
20	4073	50.2	134	107	2135	43.3	132	94
21	5801	50.0	133	110	1820	43.7	130	90
22	5448	55.1	137	110	2662	49.6	140	90
23	5152	52.2	140	93	1680	47.1	144	81
24	4635	54.2	141	100	2042	50.4	146	88
25	5033	54.2	142	95	1746	50.0	148	85
26	6405	52.3	146	87	2179	46.1	149	79
27	6477	50.8	148	100	1824	46.9	150	85
28	7298	50.1	147	108	2276	44.0	144	89
29	4516	53.4	146	90	2046	49.2	145	81
30	5097	45.2	134	88	2064	39.7	131	80
31	4177	49.4	141	102	2349	43.2	137	94
32	2946	58.4	167	135	1850	54.6	165	130
33	3462	56.7	157	110	2356	53.8	155	100
34	5359	49.8	140	90	3284	51.2	142	85
35	4614	48.1	138	82	3441	43.8	138	78
36	4572	52.3	140	83	3156	54.7	141	81
Mean	5075	51.5	142	107	2155	46.5	143	93
LSD (0.05)	560	5.2	07	15	230	3.9	05	13

* SY = seed yield (kg/ha), KW = 1,000-kernel weight (g), DH = days to heading, PH = plant height (cm), LR = leaf rust score (0 = no visible infection, Tr = traces), SP = septoria score.

Although high grain yield is the main selection criterion for variety adaptation, 1,000 kernel weight, heading dates, plant height, and disease resistance are important agronomic traits. Cultivars with plump seeds are generally more appreciated by farmers. Early maturing cultivars escape late season moisture stress. Semi-dwarf types are resistant to lodging and very responsive to the addition of water and fertilizers. Resistance to diseases is the cheapest and most efficient way to plant protection. Genetic variability for these traits was present (Table 2). Most introduced lines performed better than the local checks with regard to all these traits except for 1,000-kernel weight.

Conclusion

The superiority of some introduced lines was confirmed. The selected lines in this preliminary screening may be possibly adapted to Le Kef semi-arid region of Tunisia and could be used as cultivars there. They may also be utilized in a breeding program designed to improve the yield and other major agronomic traits of the local cultivars.

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COMMUNIQUE DE PRESSE DEUXIEME SEMINAIRE INTERNATIONAL SUR LA VALORISATION DU SAFOUTIER ET AUTRES OLEAGINEUX NON CONVENTIONNELS, 3-5 décembre 1997, Ngaoundéré, Cameroun.

Le deuxième séminaire international sur le Safoutier et autres oléagineux non conventionnels s'est tenu à Ngaoundéré du 3 au 5 Décembre 1997 dans les locaux de l'Ecole Nationale Supérieure de Sciences Agro Industrielles (ENSAI) de l'Université de Ngaoundéré (Cameroun) avec le financement de l'Institut Africain-Américain (AAI), USA, de La Coopération Technique Allemande (GTZ), du Centre Technique de Coopération Agricole et Rurale (CTA), Convention de Lomé ACP-UE, de la Commission Internationale de Génie Rural (CIGR) Belgique.

Le programme comportait une cérémonie d'ouverture, une exposition des oléagineux non conventionnels et des publications, des sessions scientifiques, des conférences débats, une visite d'usine et d'un jardin de safoutiers, une cérémonie de clôture.

Le nombre de participants à ce séminaire était de 74 dont 64 scientifiques/professionnels et 10 du personnel d'appui. Le nombre de femmes était de 11. Parmi les participants, 14 venaient de l'étranger avec 11 d'Afrique : Côte d'Ivoire (3), Gabon (1), Mali (1), Niger (1), Nigeria (4), Afrique Sud (1) et 3 d'Europe : France (2) et Allemagne (1), et 60 du Cameroun avec 35 de Ngaoundéré.

Parmi les 64 scientifiques/professionnels, on note selon les catégories:

- 89,55 % de chercheurs / universitaires
- 4,47% d'ONG / Professionnels,
- 3,0% d'Industriels,
- 3,0 % de représentants d'organisme d'aide.

Pour toute information concernant les actes du séminaire,

contacter : Dr. C. KAPSEU, Coordinateur
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Endocrine Response of Hybrid Rabbits of Different Ages and Under Two Environmental Temperature Conditions

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Keywords : Rabbit - Age - Environmental temperature - Plasma hormone profiles

Summary

The trial was carried out on 44 hybrid male rabbits in order to study the plasma levels of testosterone (T), dihydrotestosterone (DHT), cortisol (C), triiodothyronine (T_3) and thyroxine (T_4) in relation to age (71 vs 85 days) and environmental temperature (20 vs 27°C). Age did not affect T, DHT, T+DHT. Only T/DHT resulted lower ($P<0.01$) for older rabbits. The 71 and 85 day-old rabbits showed similar levels of C, T_3 , T_4 and T_4/T_3 . The different thermal levels did not influence T, DHT, T+DHT, T/DHT and C. The rabbits reared at 27°C showed similar values of T_3 and T_4 but a higher ($P<0.05$) T_4/T_3 ratio in comparison with those kept at 20°C. Digestible energy intake/metabolic weight appeared to influence ($P<0.01$) T_3 positively and T_4/T_3 negatively.

Résumé

L'essai a été réalisé sur 44 lapins mâles hybrides afin d'étudier les niveaux plasmatiques de testostérone (T), dihydrotestostérone (DHT), cortisol (C), triiodothyronine (T_3), et thyroxine (T_4) en fonction de l'âge (71 vs 85 jours) et des conditions thermiques d'élevage (20 vs 27°C). L'âge n'a pas influencé les niveaux de T, DHT et de T+DHT. Seul le rapport T/DHT s'est révélé inférieur ($P<0.01$) au 2^e prélèvement. Les lapins âgés de 71 et 85 jours ont présenté des valeurs identiques de C, T_3 , T_4 , et T_4/T_3 . Les différentes valeurs thermiques n'ont pas influencé les taux de T, DHT, T+DHT, T/DHT et C. Les lapins élevés à 27°C ont présenté des valeurs semblables de T_3 et T_4 , mais un rapport T_4/T_3 plus élevé ($P<0.05$). L'ingestion d'énergie digestible par unité de poids vif métabolique a influencé positivement ($P<0.01$) les niveaux de T_3 et négativement ($P<0.01$) le rapport T_4/T_3 .

1. Introduction

The plasma endocrine status of rabbits has been studied in some trials in relation to physiological and exogenous factors. With regard to androgens, Berger *et al.* (1, 2, 3) studied the developmental pattern of plasma testosterone and dihydrotestosterone in growing rabbits. Correlations between testosterone and sexual and behavioural development were also found (3).

Ambient stress factors such as temperature (16, 21, 22) and noise (22) resulted to affect corticosteroid plasma levels. High environmental temperature (21) influenced the thyroid hormones as well as high doses of perchloric acid ammonia (8).

Our previous research considered the influence of age and nutritive level on androgens (5). Endocrine status was also studied in relation to different thermal conditions (4). Given the scarcity of experimental work on the effect of environmental temperature and age on the endocrine response in male rabbits, the aim of the present research is to provide an insight on the effect of these factors on androgen, corticosteroid and thyroid hormone plasma profiles.

2. Material and methods

Forty-four Provisal male rabbits were used, characterized by a mean initial live weight of 989 g.

The animals were 35day-old commercial four-way crossbred type rabbits, raised under the same rearing conditions and nutritional plan during the pre and post weaning period. Commercial pelleted feed (crude protein=17.18% d.m.; crude fiber=5.48% d.m., digestible energy=10.57 MJ/kg as feed basis) was administered *ad libitum*, like for the water. The animals were randomly housed in two different rooms with rearing temperature levels of 20 ± 1.94 and 27 ± 1.23 °C. Average relative humidity values were 75 ± 7.21 % for both temperatures. The animals were reared individually up to 85 days of age in a Californian battery cage system, without hindering cecotrophy. The trial was carried out in autumn, so a heating system was used in the room at 27°C to reach this high temperature level. In the first room the ventilation was natural; the second was conditioned by an automatic control system for temperature and humidity. The photoperiod, provided by halogen lamps, consisted in 16 hours of light and 8 hours of darkness, with a light intensity

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Table I. Productive performance

		Age		Temperature		Error mean square*
		71 d	85 d	20°C	27°C	
Animals	n	20	24	24	20	
Initials BW	g	974	1005	995	983	3420
Final BW	g	2161 ^A	2643 ^B	2488 ^B	2316 ^A	36140
Metabolic BW	kg	1.40 ^A	1.57 ^B	1.51 ^B	1.45 ^A	0.0053
Weight gain	g/d	33.0	33.4	35.2 ^B	31.3 ^A	13.61
Feed intake	g/d	107 ^A	122 ^B	122 ^B	107 ^A	113
Feed efficiency	g/g	3.24 ^A	3.68 ^B	3.50	3.42	0.0605

Within a treatment, values assigned different superscript letter were significantly different ($P < 0.01$).

*: 40 degrees of freedom.

Table II. Plasma levels of some hormones

		Age		Temperature		Error mean square*
		71 d	85 d	20°C	27°C	
Animals	n	20	24	24	20	
T	ng/ml	1.38	1.18	1.60	1.06	0.9922
DHT	ng/ml	0.60	0.79	0.80	0.59	0.2621
T/DHT		2.30 ^B	1.49 ^A	2.00	1.80	0.6146
T+DHT	ng/ml	1.98	1.97	2.40	1.65	2.1273
C	µg/dl	1.85	1.65	1.78	1.72	0.2386
T ₃	ng/ml	1.12	1.08	1.16	1.04	0.0701
T ₄	ng/ml	37.8	38.0	36.6	38.7	36.62
T ₄ /T ₃		33.9	35.1	31.6 ^a	37.4 ^b	59.79

Within a treatment, values assigned different superscript letter were significantly different (A, B: $P < 0.01$) (a, b: $P < 0.05$).

*: 40 degrees of freedom.

of about 40 lux. Ammonia concentrations were similar between the two treatments, on average 8.5 ppm. Temperature and relative humidity values were constantly recorded by means of thermohygrographs (TIG - ITH -L.S.I).

At 71 (1st sampling) and 85 (2nd sampling) days of age, each rabbit was subjected to blood samplings at the same time in the morning after a fasting period of two hours. The blood was sampled from the auricular vein, collected in test tubes with 150 USP lithium heparin, centrifuged for 15 minutes at 3000 rpm and the plasma stored at -20°C until analysis. Testosterone (T) and dihydrotestosterone (DHT) plasma levels were quantified by radioimmunoassay (RIA) as described by Berger *et al.* (1). The specificity of the antiserum used [in the T-DHT RIA] was tested against related steroids and expressed as percentage of cross-reactivity. Only 5α -dihydrotestosterone had a significant cross-reactivity of about 50%, while for all the other androgens the cross-reaction was lower than 7% - 5α -Androstane- 3α , $17\beta\alpha$ diol (4%), 5α -Androstane- 3β , $17\beta\alpha$ diol (6.5%), 5β -dihydrotestosterone (1%), Epitestosterone (0.5%)-, and for both oestrogens and progestins lower than 0.05%. Cortisol (C), triiodothyronine (T₃) and thyroxine (T₄) plasma concentrations were determined using specific and standardized RIA procedures based on kits (Cambridge Medical Technology, USA) which have been validated for use in rabbits. The intra- and inter-assay coefficients of variation for each assay were

6.1-12.0%. All measurements were made in duplicate and only the values included in the limits of each method were retained.

Data were submitted to a two-way ANOVA with interaction, using the Harvey (10) package.

The correlations and regression equations between plasma hormone concentrations and some productive performance, daily gain (DG) and digestible energy intake (DEI) per unit of metabolic body weight (MBW) were calculated.

3. Results

As no significant interaction effects between age and temperature were observed, in the following tables only the main effects are reported.

Growth performances

Table 1 summarizes the productive performance exhibited by the tested rabbits. In relation to age, the 85 day-old rabbits exhibited significantly higher ($P < 0.01$) final body (2643 vs 2161 g) and metabolic weights (1.57 vs 1.40 kg). Although the oldest rabbits presented higher feed intake (122 vs 107 g/d, $P < 0.01$) the growth rate was similar between the groups (33.4 vs 33.0 g/d) resulting in a feed efficiency of 3.68 g/g in favour ($P < 0.01$) of the younger animals (3.24 g/g).

As concerns rearing temperature effects, high thermal levels induced the animals to eat less (107 vs 122 g/d,

$P < 0.01$), thus presenting a significantly ($P < 0.01$) lower daily body weight gain (31.3 vs 35.2 g). As a consequence final live weight (2316 vs 2488 g) and metabolic weight (1.45 vs 1.51 kg) were significantly lower ($P < 0.01$) in comparison with the rabbits kept at 20°C. Feed efficiency did not differ between the 20 and 27°C groups, averaging 3.46 g/g.

Hormonal profiles

The plasma levels of some hormones are shown in table II. Concerning androgen levels no difference was found between animals of different age (85 vs 71 d): T (1.18 vs 1.38 ng/ml), DHT (0.79 vs 0.60 ng/ml) and T+DHT (1.97 vs 1.98 ng/ml), but the T/DHT ratio appeared to be significantly lower ($P < 0.01$) for the older rabbits (1.49 vs 2.30). All plasma androgen levels were similar between the two temperature groups, averaging 1.33, 0.70, 2.02 ng/ml for T, DHT and T+DHT, respectively. The T/DHT ratio did not differ (mean value: 1.90).

At increasing age plasma C concentrations showed a tendential decrease: 1.85 and 1.65 µg/dl in 71 and 85 day-old rabbits respectively. The rearing temperature did not affect plasma C concentrations (average: 1.75 µg/dl).

Going on to consider the thyroid hormones, age did not appear to influence the T_3 (1.12 vs 1.08 ng/ml) and

T_4 (37.8 vs 38.0 ng/ml) concentrations nor the T_4/T_3 ratio (33.9 vs 35.1) significantly. T_3 (1.04 vs 1.16 ng/ml) and T_4 (38.7 vs 36.6 ng/ml) plasma levels did not appear to be significantly influenced by heat stress conditions. Only the T_4/T_3 ratio (37.4 vs 31.6, $P < 0.05$) significantly increased.

Table III presents only the significant correlations and the relative linear regression equations between the endocrine profile (T_3 , T_4) and the productive performance, they are graphically represented in figure 1. The DEI/MBW is correlated positively with the plasma T_3 level ($r = 0.563$, $P < 0.01$) and negatively with the T_4/T_3 ratio ($r = -0.589$, $P < 0.01$).

Table III. Linear regression equations (1) relating plasma T_3 (y1), T_4/T_3 (y2) and DEI/MBW (x1)

Linear regression equation	Residual Standard Error	r
$y1 = -0.676 + 0.002 x1$	0.2225	0.563**
$y2 = 91.462 - 0.078 x1$	6.5425	-0.589**

(1) Number of observations: 44

** = $P < 0.01$

4. Discussion

The absence of interaction between age and rearing temperature indicates a similarity of growth and physiological reactions to heat stress conditions in animals of both ages considered.

As concerns the productive performance in relation to age, the older rabbits exhibited higher final live weight and daily intake with a significant worsening of feed efficiency. The negative effect of increasing age on feed efficiency was already observed in previous experiments (6, 17). A marked effect of the environmental temperature was compared to the younger rabbits, observed on almost all field performances: heat stress induced a significant decrease of final body weight and growth rate because of a lower feed intake, thus decreasing the extra heat to be dissipated to the environment and limiting the energy loss due to thermolysis.

As concerns hormonal profiles, age did not have a significant effect on steroids levels, due to the limited interval of time considered during this stage of life. In fact, Berger *et al.* (2, 3) and Chiericato (5) found a significant increase in plasma T and DHT levels in growing rabbits, considering however a larger time interval. The period of time considered in this experiment enabled us to observe only a significant variation of T/DHT ratio, caused by a decrease of T with respect to an increase of DHT in rabbits aged between 71 and 85 days. As the nutritive level influences the steroid plasma concentrations (4, 5), these results have to be considered in relation to the feeding plan. The more intensive feeding adopted in this experiment led the rabbits to higher precocity levels, reaching sexual maturity earlier, with higher androgen plasma levels. These findings, together with those reported in a previous experimental work (5) point out the importance of feeding program effects and their possible interac-

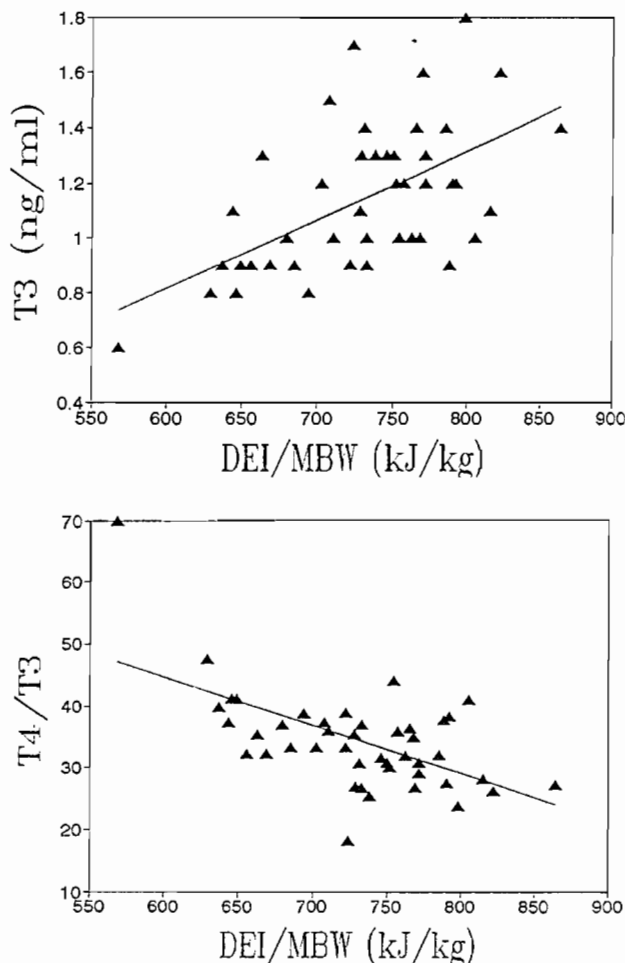


Figure 1. Relationships between T_3 , T_4/T_3 ratio and DEI/MBW

tions with age on the androgen plasma concentrations in rabbits. Going on to consider the effects of temperature, the androgens exhibited plasma values tendentially lower in the heat stressed animals. Similar results were obtained in a previous study where a wider temperature range than the present (12°C to 30°C) was adopted (4). These results, in view of the indications of a previous research work (4), suggest studying the relationships between nutritive levels, ambient thermal conditions and plasma androgen concentrations, considering a wider range of temperatures. A comparison of these data with those obtained by other authors is difficult, particularly for testosterone because of the different concentrations in relation to age and the well-known pulsatile pattern (15, 19) of this hormone. However, the present values are within the range reported by other experimental contributions carried out on rabbits (1, 4, 5, 15, 19).

The blood sampling carried out on 85 day-old rabbits, compared to that observed at 71 days of age, did not show a significant difference in plasma C levels, but only a tendential decrease. Given the scarcity of available literature on this topic, the decrease of cortisol levels in growing rabbits is hardly documented. Our findings are in agreement with results obtained by other researchers (16) who observed a cortisol decrease in plasma with increasing age (50 d to 80 d). In other monogastric species, such as swine (11, 14) cortisol is affected by the age of the animals. Hot environment conditions were not able to influence the plasma C levels notably. It is possible to point out that the rabbits reached a homeostatic state probably overcoming the initial alarm reaction stage induced by the high temperature. This conclusion is confirmed by data relating to some corticosteroid hormones obtained by Spanish authors (22) and in our previous trial (4), where a markedly wider temperature range was tested. Our data are not in accordance with the findings of Trammel *et al.* (21) who found a decrease in cortisol levels in heat stressed rabbits adopting temperature levels different from ours (16.8 vs 32.2°C) in a more limited period of time (23 d). Considering other monogastric species such as swine, the cortisol plasma levels (18) present an increase in presence of low rearing temperatures due to calorigen action. The cortisol levels of this trial

are similar to those found at the University of Arkansas (21) and in Italy (4).

Going on to consider the thyroid hormones, they appeared to be similar between the two age categories of rabbits studied. There is a substantial absence of experimental contributions on the effects of age on these hormones in rabbits. In chickens, T_3 concentrations decreased throughout the productive cycle, while T_4 increased with increasing age (12, 13). In relation to temperature effects, only the T_4/T_3 ratio is affected significantly by the treatment, increasing in the rabbits kept at 27°C. This variation is due to an increase in T_4 and to a decrease in T_3 in hot conditions. The results reported by literature are not homogeneous (16, 21) due to the different environmental temperature conditions tested. This fact points out the need for further studies to be conducted in similar environmental conditions, thus enabling comparison. It may be worth mentioning that hormonal response to environmental temperature can be opposite, depending on the length of thermal exposure (7). The temperature effect on thyroid functions has been studied in other farm species, such as poultry. In chickens, T_3 decrement and T_4 increment were observed with increasing temperature (20). Hormonal levels exhibited by the rabbits in this trial are similar to those found by other researchers (8, 16, 21).

The productive performance was significantly correlated with the endocrine response of the animals. In particular, T_3 was positively affected by DEI/MBW, while T_4/T_3 ratio appeared to be influenced negatively by DEI/MBW. It is known that the increase of caloric intake in individuals results in an increased diet-induced thermogenesis; the increased levels of T_3 apparently derive from increased peripheral conversion of T_4 to T_3 and a decreased conversion of T_3 to rT_3 (9). Similar relationships were found in our previous work (4) where a wider range of temperature was adopted, pointing out that the thyroid endocrine response takes place in a rather wide range of thermal values.

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PRESS RELEASE

SECOND INTERNATIONAL WORKSHOP ON THE IMPROVEMENT OF AFRICAN PEAR AND OTHER NEW SOURCES OF VEGETABLE OILS

The second international workshop on the improvement of African Pear and other new sources of vegetable oils took place at Ngaoundéré from 3rd to 5th December 1997 in the premises of the Advanced School of Agro-process Industries (ENSAI) of Ngaoundéré University (Cameroon). This workshop was sponsored by the African Training for Leadership and Advanced Skill (ATLAS), African-American Institute (AAI), New York, USA, International Service of Appropriate Technology, GTZ, Germany, The (CTA), ACP-Lomé Convention and the International Commission of Agricultural Engineering (CIGR), Belgium.

The agenda included opening ceremony, samples show, presentations, panel discussions, meeting of the scientific organisation (ASANET, ACAGER), visit of the factory and African pear accessions, and closing ceremony.

The number of participants at this workshop was 74 with 64 scholars/professionals., and 10 academic staff. The number of women was 11. Among participants, 14 came from abroad with 11 from Africa : Ivory-coast (3), Gabon (1), Mali (1), Niger (1), Nigeria (4), South Africa (1) and 3 from Europe : France (2) and Germany (1), and 60 from Cameroon with 35 from Ngaoundéré.

Among 64 scholars/professionals, the distribution was as follows:

- 89.5% of scholars
- 4.5% of non governmental organisation delegates
- 3.0% of industrials
- 3.0% sponsor representatives

For any information concerning the workshop proceedings

Please contact : Dr. C. KAPSEU, Coordinator
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Preliminary Results on Artificial Insemination of Cattle in Suriname. Case Study : Commewijne District

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Keywords : Cattle - Dairy production - Artificial insemination - Fertility - Suriname

Summary

In 1990 and with the help of the European Development Fund, a new and completely equipped AI-station was set up in an attempt to improve the genetic basis of the dairy herd in Suriname. Countering the dramatic decrease in local milkproduction being the main consideration. The author reviews the technical results of three years of AI in the eastern district of Commewijne. The AI-service which was directed from the capital in 1992 and 1993, was decentralised towards the regional veterinary service early 1994. The effects of this decentralisation are also discussed.

Technical results realised during the first three years of AI in the Commewijne district are in general disappointing. Only a small number of dairy farmers makes use of AI, while conception rates are low. The results clearly indicate that heat detection is a major problem, leading to long calving intervals. The kind (breed) of semen used does not influence conception rates. On the other hand, the technical skills of the inseminators involved do influence conception rates. So does the ethnic origin of the farmers involved, although this parameter is closely linked to the scale of the farms and the management level.

At first sight, it would seem that decentralisation had a positive effect on technical results. Due to an increase in the number of inseminations performed, the number of AI-calves born increased substantially. Technical results however were inferior to those prior to decentralisation.

Samenvatting

In een poging de neerwaartse tendens in de lokale melkproductie in Suriname tot staan te brengen, werd in 1990 een projekt opgezet, gericht op de heractivering van de kunstmatige inseminatie van melkvee. Met de hulp van het Europese Ontwikkelings Fonds werd er een nieuw en volledig uitgerust KI-station opgezet. De auteur bespreekt de technische resultaten van de eerste drie jaren kunstmatige inseminatie in het oostelijke district Commewijne. De dienstverlening die in 1992 en 1993 vanuit de hoofdstad plaats vond, werd begin 1994 gedecentraliseerd naar de regionale veterinaire dienst toe. De effecten van deze decentralisatie worden eveneens geanalyseerd.

De technische resultaten die in de eerste drie jaren in dit district behaald werden, zijn over het algemeen teleurstellend. Slechts een klein deel van de (melk)-veehouders neemt deel aan het programma terwijl de bevruchtingsresultaten onbevredigend zijn. Uit de analyse van de gegevens blijkt dat het herkennen van de tochtigheid een groot probleem vormt, hetgeen op zijn beurt aanleiding geeft tot lange tussenkalftijden. Het type (ras) diepvriessperma heeft geen invloed op de bevruchtingsresultaten, de technische prestaties van de inseminatoren echter wel. Hetzelfde geldt voor de bevolkingsgroep op wiens bedrijven geïnsemineerd wordt, met dien verstande dat deze parameter nauw samenhangt met de grootte van de bedrijven en het management niveau.

De effecten van de decentralisatie leken eerst positief. Het aantal KI-kalveren nam beduidend toe. Dit was echter vooral een gevolg van een groter aantal inseminaties, de technische resultaten gingen er op achteruit.

Introduction

For most of the fifties and part of the sixties Suriname managed to be selfproviding in dairy products. The flourishing dairy sector was supported by a governmental artificial insemination service (established in 1952) which had quite some success and dispersion. A peak in the number of inseminations was reached in 1965 with nearly 6000 inseminations per year. In subsequent years this number had dropped drastically and there appears to be a relation to milk supply, rather than to the number of cows. Reasons why milk-supply decreased were the expansion of the urban area, the stagnation of the milkprice paid by the sole

authorised milkprocessing plant, Melk Centrale Paramaribo (established in 1962) and labour shortage (1). The severe economic crisis which struck Suriname in the eighties led to the virtual destruction of the dairy sector in this country. By 1992, when inflation rose to over 300% per annum milk supply to the milkplant had reached its lowest level since it was established. The development of the dairy sector is now one of the key targets within government policy, especially in the view of import substitution of milkpowder, for which foreign currency is no longer available.

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In 1990 a new artificial insemination service was set up at the abattoir site in the capital Paramaribo. Project n° 5100.35.59.011 (Verbetering van de K.I. in Suriname) was funded by the European Development Fund and included funds for a modern building, liquid nitrogen production apparatus, several small four wheel drives, the necessary equipment for inseminations and tagging of cows and calves and of course imported semen (Holstein and Australian Milking Zebu). The new AI-service has been working as a government service for some 5 years. The aim is to privatise the whole system within the next years.

Although the AI service has had all the necessary equipment needed, insemination of cattle presumably never rose to a relevant qualitative and quantitative level, the ongoing deterioration of the dairy sector being one of the main limitations. Furthermore, while severe inflation increased the cost of living, inseminators kept their same government salary, which led quite some inseminators to leave the service, whereas the remaining inseminators got demotivated. There were no financial incentives as to the quality of their work, neither to the quantity of their work, e.g. weekend allowances were (and still are) virtually symbolic.

This is probably why the service has been limiting itself to the insemination of cattle and never really performed pregnancy-checks and calf-registration measures. Therefore, and because of the lack of computerised dataprocessing, data on the quantity and quality of AI in Suriname were not available until this year (1995).

In 1991, the more remote districts of Commewijne (east of Paramaribo) and Saramacca (west of Paramaribo) were added to the area covered by the inseminators of the AI service in Paramaribo. As from the start inseminations in the Commewijne district were scarce and results (presumably) poor; this was due to the fact that inseminators needed to cross the Suriname, river by ferry, which often is a hazardous undertaking (strikes, technical failures, etc ...). This meant that inseminators often arrived too late for an insemination to be successful.

Since December 6th, 1993 this service to the Commewijne district has been decentralised, which means that the service is now part of the regional veterinary service, which performs inseminations with its own personnel and makes use of equipment, transportation and semen from the Paramaribo AI-service. Since there is no need to cross the Suriname river every day, one would expect better technical results, due to the fact that one can be at the farmers site more quickly and that inseminations can be performed during weekends, which was not the case in the previous system.

The technical results of inseminations in this district for the period 1992 - 1994 (before and after decentralisation) are presented and discussed hereunder.

Material and methods

The data used in this report were collected from the data-sheets, used by the subsequent inseminators.

These consist of individual cow-records (given to the farmer), farm-records (several cows per farm) and insemination records (per inseminator). Overall data available are:

- farm-owner (and ethnic group),
- farm-address,
- farm-registration number,
- name of the cow and cow-eartag number,
- date, invoice-number and semen-choice of first, second, third and/or fourth insemination,
- name of the inseminator and insemination fee.

Unreliable and/or incomplete data were pregnancy-checks, previous calving date, following calving date, calf-eartag number, sex of the calf, fertility-related problems and treatments.

Based on the reliable and complete data available, a computer-program was developed using a database-program called FileMakerPro™, running on an Apple™ Macintosh™-processor. Additional inputs required were:

- results of pregnancy-checks and
- previous calving dates(s).

These additional data were collected through farmvisits. Having these data available, the computer-program calculated a number of additional data for each record (cow):

- expected calving date,
- intervals between inseminations

Based on these data, farm-visits and calf-registration were organised, whereby

- conception (birth/no birth),
- date of birth,
- sex and
- eartag-number

of calves were entered into the database, which enabled the program to calculate

- pregnancy length and
- calving interval.

Once these data were available, the program calculated a range of technical parameters for either a given area, a given ethnic group, a given period of time, a specific farmer, a specific inseminator, a specific choice of semen or any other choice. These parameters were :

- number of AI-farms
- number of AI-cows
- overall number of inseminations
- number of AI-calves born
- number of heifer-calves born
- number of bull-calves born
- average interval between two inseminations
- average number of inseminations per conception
- total number of conceptions following first insemination
- total number of first inseminations
- average calving interval
- average pregnancy-length
- choice of semen

Additional calculations led to the following important parameters:

- average conception rate following first insemination and
- overall average conception rate.

As mentioned above, all these parameters are available for a given period of time, a given bull, a given inseminator or whatever other possibility chosen. The 60- or 90-day non return percentage was not calculated since this parameter is probably of very little value under the Surinamese circumstances in which a lot of farmers switch towards natural service or sell their cows for beef in the occurrence of non-conception following a first insemination.

The conception rates following first insemination in relation to different periods of time (before and after decentralisation), the different technicians involved, the choice of semen and the ethnic origin of the farmers involved, are being compared statistically using a student t-test.

Results

The results presented hereunder cover the period January 1992 - January 1995. However, we make a clear distinction between the periods preceding and following decentralisation on December 6th, 1993, since this will show to have had an important impact on several technical results. This date marked not only the decentralisation of the service towards the district, but also the enrolment of two new inseminators, which is an important variable in all AI-calculations.

Between January 1st, 1992 and December 31st, 1994, 354 inseminations were performed on 277 cows on 171 different AI-farms in the Commewijne district.

On 103 occasions, Holstein semen was the semen of choice (39,7%), 156 inseminations were performed using Australian Milking Zebu-semen (60,3%). The average interval between two inseminations added up to 112 days instead of the usual 21 days. The average pregnancy length was 279 days. The calculated average calving interval was 567 days or 1,5 years, whereas 385 days is considered acceptable under tropical conditions. Table I presents these results for the subsequent years.

Table I. Overview of insemination data from January 1 st, 1992 until December 31 st, 1994.

Year	1992	1993	1994
Number of AI-farms	54	23	94
Number of AI-cows inseminated	76	40	161
Total number of AI performed	99	46	209
Average interval between two inseminations (days)	154 d	90 d	87 d
Choice of Holstein-semen	38	19	46
Choice of AMZ-semen	38	20	98

In 1992, 1993 and most of 1994, the cost of an insemination remained at the same level (Sfl.10,-). The

number of inseminations increased considerably after decentralisation in 1994. It was only after the price of inseminations was adapted to Sfl. 750,- on November 1st, 1994, that the demand for inseminations diminished.

The monthly number of first, second, third and fourth inseminations for these three years are presented in figure 1.

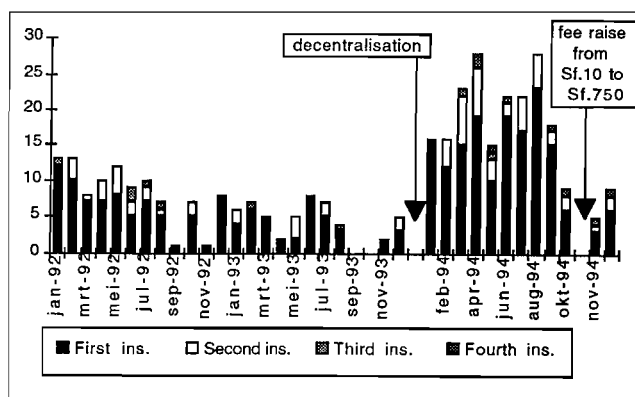


Figure 1. Monthly insemination-data from January 1st, 1992 until December 31st, 1994

In order to compare the results in three consecutive years without the interference of price changes and/or seasonal influences, we compared the technical results in the first five months of 1992, 1993 and 1994. The cost of an insemination remained the same during these three periods.

The technical results of first inseminations performed in the period January 1st until May 31st, 1992, 1993 and 1994 respectively are being presented in table II.

Table II. Overview of technical results for the period January 1st until May 31st, 1992, 1993 and 1994. (normal [no] values between brackets)

Year (January 1st - May 31st)	1992	1993	1994
Total number of files	44	20	72
Total number of files completed	41	20	66
Number of AI-farms	30	9	37
Number of AI-cows inseminated	41	20	66
Total number of AI performed	57	23	96
Average interval between two inseminations, [no = 21 days]	158 d	84 d	98 d
Total number of calves born	18	13	33
Total number of heifer calves born	7	7	20
Total number of bull calves born	11	6	13
Number of inseminations. per conception (overall)	3,16	1,76	2,91
Number of inseminations per conception (pregnant cows only) [no = 1, 5]	1,66	1,26	1,77
Average overall conception rate	44%	65%	50%
Total number of first inseminations	41	20	66
Total number of conceptions following first insemination	14	11	20
Average conception rate following first insemination	34%	55%	30%

Choice of Holstein-semen at first insemin.	23	11	14
Average conception rate following first insemination using Holstein	22%	64%	35%
Choice of AMZ-semen at first insemin.	18	9	52
Average conception rate following first insemination using AMZ	50%	44%	28%
<hr/>			
Total number of first inseminations performed by inseminator X	41	20	0
Average conception rate following first insemination by inseminator X	34%	55%	
Total number of first inseminations performed by inseminator Y	0	0	49
Average conception rate following first insemination by inseminator Y			37%
Total number of first inseminations performed by inseminator Z	0	0	17
Average conception rate following first insemination by inseminator Z			12%
<hr/>			
Average pregnancy length [no = 280 days]	277 d	278 d	281 d
Average calving interval [no = 385 day]	480 d	437 d	745 d

The overall technical results for first inseminations performed in the period January, 1st, 1992 until May 31st, 1994 were as follows. 177 cows were inseminated on 233 different occasions and on 109 different farms. The average insemination-interval between two inseminations was 124 days. In 68 (first) inseminations, Holstein was the semen of choice (38,4%), whereas in 108 cases, Australian Milking Zebu was chosen (61,6%). Out of these 177 cows, 90 calves were born, of which 42 heifers (46%) and 48 bulls (54%). The average conception rate following first insemination was 38,41%, while the average overall conception rate was 50,84%. Thus, only one out of two cows eventually got pregnant. The average pregnancy length was 278 days, the calving interval amounted to 590 days.

In an attempt to identify the group of farmers who would be most in need of extension and possibly training concerning heat detection and other AI-parameters, we processed the 1994-results, based on ethnic origin, the three majority populations being (in random order) : creole (african), hindustani (indian subcontinent), and javanese (indonesian archipel). The results are presented in table III.

Table III. Technical results for the period January 1st until May 31st, 1994 in relation to the ethnic origin of the farmers involved

January 1st - May 31st, 1994	Creole farmers	Hindustani farmers	Javanese farmers
Total number of first inseminations.	11	40	13
Total number of conceptions following first insemination	6	13	1
Average conception rate following first insemination	55%	32%	8%

From the parameters presented in the previous paragraphs only two parameters are of major interest to the farmer and the government (who is heavily supporting this AI-program) : what is the effect of decentralisation on (a) calf-output and (b) on the cost per AI-calf born?

The output of AI-calves increased significantly after decentralisation of the AI-service, though more through a higher number of inseminations than through better technical performance. Indeed, the number of inseminations during the first five months of 1994 more than tripled in comparison to the same period in the previous year. On the other hand conception rates decreased from 55% in 1993 to merely 30% in 1994. These results are visualised in figure 2 by adding the number of first inseminations (n) to the value referring to the conception rate following first insemination (%).

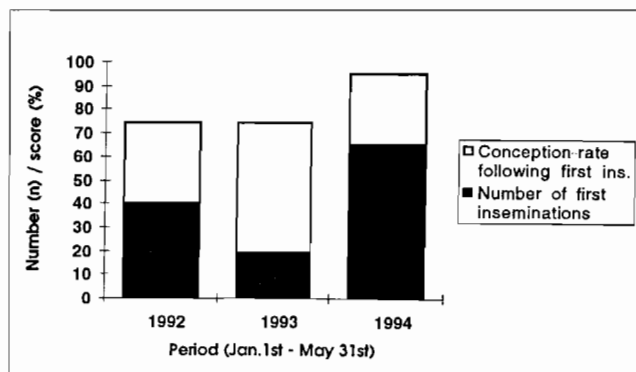


Figure 2. Calf output as a result of the number of inseminations (n) and the conception rate (%) before and after decentralisation

The cost of an AI-calf is closely related to the number of inseminations per conception per cow. While the number of inseminations for the cows that eventually got pregnant remained more or less acceptable before and after decentralisation (1,26 in 1993 and 1,77 in 1994), the overall number of inseminations for all the cows that had been inseminated, increased significantly in 1994 (2,91 in comparison to 1,76 in 1993). Roughly estimating the actual cost of one insemination at approximately US\$ 10, this would mean an extra cost of US\$ 11,5 per AI-cow calving in comparison to the previous year. It needs to be pointed out however that the overall number of inseminations per cow was even higher in 1992 (3,16 inseminations/cow).

Discussion

The results presented hereabove are based on relatively small numbers of data and are therefore not always of statistical value. Suriname is a very sparsely populated country (estimated 400,000 inhabitants), with a very small portion of the country being used for habitation and agricultural production (the coast line and parts of the savanna); the remaining part consists of dense tropical rainforest (the Amazon forest). The national herd represents an estimated 93,180 number of cattle (1) (1991 census). The Commewijne district is a rural coastal district, neighboring the capital Paramaribo. The district has an estimated population of 24,000 and an estimated cattle herd of 10,521 (1993 census) (2). Most of the cattle may be considered beef cattle, the greater part being raised on a few semi-extensive enterprises. Estimations of the dairy

herd are not available. Specialised dairy enterprises are almost non existing, dual purpose being the rule. As in most other parts of the country and for the time being, dairy production remains a sector of minor economic importance, which is why A.I. has never become quite as important as policy-makers might have hoped.

Overall technical results

Although several authors (5, 6) consider conception rates at first insemination of 60% or higher to be achievable under tropical rearing conditions, practice reveals far less elevated conception rates. Thatcher and Collier (7) reported on conception rates at first insemination of 47% in heifers and merely 32% in lactating cows on a commercial dairy herd in (tropical) Florida (U.S.A.). The conception rates following first insemination that were revealed through this study are in accordance with those data and may be considered acceptable given the circumstances. Overall conception rates on the other hand, are very disappointing since in average only one out of two cows eventually gets pregnant. Cows that do get pregnant need no more than 1,58 inseminations in average, which is normal. The overall number of inseminations per conceived cow on the other hand is high: 2,59 in average.

What could cause these poor results ?

Based on the average interval between two consecutive inseminations (112 days) and the average calving interval (567 days), it is obvious that heat detection is a major problem. This is due to a relatively low level of education (and experience) of farmers with regard to artificial insemination. Uncontrolled natural service used to be the general practice, very few farmers understand the phenomenon of oestrus and ovulation, even fewer recognize the symptoms and behavioral changes of the animal in heat. Furthermore, it needs to be said that the genetic basis of the dairy cows makes heat detection even more hazardous. A large number of dairy cows are descendents of temperate climate-breeds, such as Holstein or Holstein Friesian or (Dutch) Friesian. The larger the influence of these breeds, the more oestrus and fertility are suppressed by temperatures exceeding 24° C (4, 7), which is usually the case in Suriname, maximum temperatures (under shade) varying from 28°C to 43°C throughout most of the year (3). Cows are kept on pasture during the day-hours and are housed at night. An even larger portion of the cows has a firm genetic *Bos indicus* (Zebu)-influence, characterised by seasonal ovulation, atypical oestrus behavior, short or even suppressed oestrus activity, nocturnal oestrus activity and early ovulation. The only breed for which heat detection would not seem to cause any problem is the indigenous Criollo. Pure-bred Criollo-cows unfortunately produce very little milk.

A large portion of the inseminated cows never gets pregnant. Some of them eventually conceive through natural service, an even larger part however suffers from infertility, nutritional deficiencies and heat-suppressed oestrus probably being the major causes.

As far as our records are concerned, the type of semen used is not a factor affecting technical results ($p > 0,10$). Conception rates differ, but in no particular way. In 1992, conception rates using AMZ were superior to those using Holstein, while in 1993 and 1994 we found the opposite to be true.

Factors undoubtedly affecting technical results are the experience and technical skills of the inseminators involved. The technical results of the (first) inseminator (X) improved (though not significantly) during his second year of practice (1993). Overall technical results of the two new inseminators (Y and Z) in 1994 were inferior to those of inseminator X in 1993. Data show that inseminator Y has obtained better results (conception rate at first insemination : 37%) than inseminator Z (conception rate at first insemination : 12%), although the difference is not significant ($0,05 < p < 0,10$). Training, the (lack of) experience and the number of inseminations performed by inseminators are in our belief, important factors to keep in mind when trying to improve technical results in artificial insemination. On the other hand, financial bonuses paid to inseminations for cows conceiving in response to AI, have (in other countries) also proven to be an effective mean of improving technical results (5).

The segment of farmers who would appear to be most in need of information regarding heat detection and record keeping, appear to be the Javanese. The technical results obtained on Javanese owned farms were significantly ($p < 0,05$) inferior to those obtained on Creole-owned farms and nearly significantly inferior ($0,05 < p < 0,10$) to those obtained on Hindustani-owned farms. Indeed, field experience confirms that these Javanese owned farms are usually the smaller ones, typically characterised by lack of land, lack of technical skills and often lack of motivation, leading to overall poor production results in terms of milk production and calf mortality especially. Since husbandry is in most cases a second occupation, next to a government or private employment, there is often no will to improve results or to enlarge the scale of the operation. As expected, there is no significant difference between technical results obtained on Creole-owned farms and on Hindustani-owned farms.

Finally, an aspect which has not been investigated, is calf mortality in AI-calves, which we suspect to be much higher than average. Improving the number of inseminations and technical results with regard to conception rates, is of little value if calf rearing management measures are not improved in the same way.

Effects of decentralisation

Decentralisation of the AI-service towards the regional veterinary service has proven to be an improvement in terms calf output. Thanks to a definite increase in the number of farms switching towards AI in stead of natural service and an increase in the number of cows being presented to the AI-service, the number of calves born as a result of the inseminations performed during the first five months of 1994, increased with 250%. Unfortunately, these figures might have been even more positive if the conception rate following first

insemination could have been maintained at the level of the previous year and the previous inseminator (55%); in stead it dropped significantly ($p < 0,05$) to merely 30% in 1994. This increased the AI-related cost of an AI-calf with approximately 40%. The decrease in conception rates is probably at least partially related to the relative lack of practical experience of the new inseminators. While inseminator Y scored an average conception rate of 37%, inseminator Z scored even less, merely 12%. Efforts to improve the quality of the inseminations performed by both inseminators, but especially inseminator Z, could improve overall calf output in the near future. The average conception rate scored by inseminator X during his first months of work (1992) was quite (though not significantly) inferior (34%) to his results during the second year (55%), which might indicate that experience improves technical results.

The technical results presented hereabove might very well be different from results in other parts of the country. Area's such as Rijdsdijk and Reeberg might show better technical results, due to the presence of larger and more specialised dairy enterprises. Unfortunately insemination and calf-registration data are not available for these areas. So far, the Commewijne district is the only district for which these data are available.

Recently, an attempt has been made to adjust the computer-program used in Commewijne in order to fit the demands of the main A.I. service in Paramaribo. The insemination data for the urban area and the surrounding districts are currently being entered into this program. However, unless calf-registration is undertaken on a structural basis, technical results won't be available for the years to come.

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ADDENDUM

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Physiological Specialization of *Septoria tritici* in North-Africa

Naïma Boughalleb* & M. Harrabi**

Keywords : *Septoria tritici* - Durum wheat - Physiological specialization.

Summary

Five isolates of *Septoria tritici*, collected from durum wheat originating from four locations of Tunisia: Tunis, Fretissa, Bizerte, Pont Bizerte and from Algeria, were inoculated on a set of eight durum wheat cultivars. The isolates were investigated in terms of their morphological characteristics as well as their variability. Physiologic specialization of the pathogen was clearly demonstrated as a result of the differential interaction between the durum wheat cultivars and the isolates. The five isolates could be grouped into three distinct groups according to four evaluation methods: the linear infection index (LII), pycnidia density (PD), percentage of attack severity (PAS) and percentage of necrosis as evaluated by loss of chlorophyll rate (CR). The results showed that the LII and PAS are more useful to discriminate between isolates than the PD and CR.

Résumé

Cinq isolats de *Septoria tritici* sur blé dur collectés de quatre régions de Tunisie: Tunis, Fretissa, Bizerte, Pont de Bizerte et un isolat d'Algérie ont été utilisés pour étudier leur réaction sur huit variétés de blé dur. Les isolats ont été identifiés en terme de leur caractéristiques morphologiques et pathologiques. La spécialisation physiologique du pathogène a été clairement démontrée comme résultat de l'interaction entre les variétés différentielles et les isolats. Les cinq isolats pourraient être classés en trois groupes distincts en se basant sur quatre méthodes d'évaluation: l'indice d'infection linéaire (LII), la densité des pycnides (PD), le pourcentage de sévérité de l'attaque (PAS) et la teneur en chlorophylle (CR). Les résultats montrent que le LII et PAS sont plus utilisés pour mieux discriminer les isolats que la PD et le CR.

Introduction

Mycosphaerella graminicola (Fuckel) (anamorph: *Septoria tritici* Rob. ex. Desm.) causes *Septoria tritici* blotch on wheat which is a serious threat to wheat production in the Mediterranean countries. Yield losses from slight to 60%, have been attributed to natural infection (9, 26). Losses occasionally may be as high as 70% (15). Yield losses are often accompanied by corresponding decreases in grain weight (5, 9, 14, 26). The severity of the disease is closely related to rainfall frequency and cool weather conditions (25). Consequently, severe epidemics have been sporadic in most geographic areas.

Breeding for resistance is generally considered the best method of control. Genetic resistance in durum wheat (*Triticum durum* L.) has been reported by several authors (4, 12, 13, 21, 24, 27). Different models of inheritance were suggested including monogenic control (5, 14, 20, 22), control through two additive genes (14) and control by several genes (7).

Physiologic specialization has not been studied extensively. Although many authors have showed the absence of physiologic races of *Septoria tritici* (1, 2, 3, 8, 14, 17, 18, 19); others have demonstrated the contrary (6, 11, 16, 23, 26).

Morales (13) tested the host-pathogen interaction using four isolates of *S. tritici* from 16 durum wheat cultivars. No physiologic specialization of the pathogen was reported. Then, Perello et al. (17) test-

ed 10³ isolates of *Septoria tritici* originating from different areas in Argentina. They concluded that there were no true physiologic races. Sipton et al (27) found at least three races. In Argentina, preliminary searches revealed a certain degree of physiologic specialization (6, 16).

Saadaoui (23) tested 19 isolates collected from different wheatgrowing areas of Morocco and inoculated them to a set of seven wheat cultivars used as differentials. He concluded that the virulence groups identified could be considered as physiologic races of *Septoria tritici* in the conventional sense.

In view of the importance of physiologic specialization for a sound breeding program, the present study was undertaken to determine whether physiological races of *S. tritici* occur in the North-African region.

Material and methods

Isolation and inoculum production

Five isolates of *Septoria tritici* were cultured from infected wheat leaves collected from Tunis, Fretissa, Bizerte, Pont Bizerte and Algeria. These isolates were obtained from leaves with typical lesions. Conidia were released from pycnidia by immersing a leaf in approximately 5 ml of sterile distilled water and the resulting conidial suspension was streaked onto the surface of PDA plates (20 g of Potato-Dextrose-Agar,

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5 g of glucose in 1 liter distilled water). Cultures were grown at 22°C for 10 h under UV and white fluorescent lighting (22 microEm²). After 3-5 days, several creamy pink-colored colonies from each plate were transferred to other PDA plates for multiplication.

Inoculum for each isolate was prepared from culture plates (10 days-old). Suspensions were adjusted to approximately 1x10⁷ conidia per milliliter with a hemacytometer. Their morphological variability was studied on the basis of color of spores, size of pycnidiospores and production of spores.

Hosts

Septoria isolates were inoculated to a set of eight cultivars used as differentials. The durum wheat cultivars are: Razzak, Maghrebi, Karim 80, Ben Bechir 79, Badri, Amal, CHEN'S'-CD 26406-3B-5Y-OM-16Y-OB and CHEN'S'-CD 26406-1B-1Y-2Y-OM-1Y-OM originating from the International Maize and Wheat Improvement Center (CIMMYT) and selected in Tunisia.

The experiment was carried out in the growth chamber under controlled conditions of 20°C for 12 h under UV and white fluorescent light of 22 microm²s⁻². The seeding was done, on a sterilized sand and in aluminium trays. A randomized design with three replicates was used. The eight varieties were sown in the same tray. The susceptible control was the wheat cultivar Morocco.

The seedlings were inoculated at the two leaves stage by spraying with a spore suspension of 10⁷ spores per milliliter as determined by hemacytometer counting. The trays were placed in a dew-chamber (relative humidity 100%) for 48 h before transferring to the growth chamber.

Disease assessment

Three criteria were used to characterize the isolates morphologically:

1. Sporulation was determined by counting the number of spores per milliliter using a hemacytometer.
2. Size of spores by measuring the length and width of 10 spores taken at random.
3. Cultures color: the culture which varied between rose-coloured and black were described visually on PDA medium.

The disease was scored after full symptom development 21 days after inoculation. Virulence assessment was estimated by four evaluation criteria: linear infection index (LII), calculated as a ratio between total lesions length and total leaf length. Pycnidia density (PD), calculated as the number of pycnidia per unit of leaf area. The percentage of attack severity (PAS) based on a 10-step scale ranging from 0=0% of infection to 9=90% of leaf area destroyed. The last criterium is chlorophyll rate (CR) determined using the following formula:

$$CR = \frac{E652 \times V \times 10}{X \times 36}$$

E652: value of absorbance on spectrophotometer at 652 nm.

CR: chlorophyll rate (mg chl/g dried weight).

V: necessary volume of acetone for extraction (ml).

X: weight of dried extract (g).

To determine chlorophyll rate, we take wheat leaves samples from every treatment (check, leaves inoculated separately with different isolates). Each sample was grinded mixed with 5 ml of cooled acetone (100%) and put in a bottle in the freezer. The next step is the mixing in order to get a very fine residue which will allow us to extrate soluble chlorophyllian pigment. After, the centrifugation of 3000 trs/mn was done at temperature of 5°C and for 10 mn. The floater was collected in erlenmeyer and stored in the freezer. The residue was again mixed in cooled acetone of 80%. After the second centrifugation, all the previous steps were remade to obtain residue without chlorophyll. The volume of all floater was determined and the residue will be dried at 60°C to get dry weight of the utilized sample. To determine chlorophyll rate, 1 ml of the floater was mixed with 9 ml of acetone (80%), 1 ml of this mixture was taken to be introduced in spectrophotometer. The adjustment at zero is done with acetone solution of 80%. For statistical analysis, an analysis of variance (ANOVA) was performed with the main emphasis on isolate x cultivar interaction.

Results and discussion

All Septoria isolates demonstrated significant differences for the three morphological characters considered.

The color of culture is a differential criterium which explain the wave length in which light is absorbed. The differences in color indicate variation between isolates. Thus, we grouped the 5 isolates into 3 different classes. The first group (Tunis and Fretissa) had a pale gray color, the second (Bizerte and Algeria) had gray color and the third one (Pont Bizerte) had gray-rose color.

The length and the width of 10 pycnidiospores taken at random in the inoculum suspension varied between 10.25 - 63.55 micro x 2.05 - 4.1 micro with mean of 31.82 + 11.35 x 3.17 + 0.82 (Table 2). Dimensions varying from 8 - 35 x 0.8 - 3 micro were found by Sanderson et al. (25) Shipton et al. (27) and Sprague (28).

Analysis of variance demonstrated significant differences between isolate dimensions (Table 1). Three homogeneous groups for spore length were distinguished. The first group is formed by Tunis and Algeria isolates. The second group is composed by Pont Bizerte and Fretissa isolates and the last one contains the Bizerte isolate.

The sporulation was estimated as the number of germinating spores per unit of volume of the inoculum.

Table 1: Length and width in microns of spores of Tunis, Bizerte, Pont Bizerte, Fretissa and Algeria isolates.

Dimensions of spores in microns

Isolates	Length (*)	width (*)
Tunis	26.42 a	3.12 ab
Bizerte	43.87 b	3.69 b
Pont Bizerte	34.40 ab	2.75 a
Fretissa	29.81 ab	3.16 ab
Algeria	24.56 a	3.12 ab

* - mean of 10 replications.

Table 2 presents production of spores per milliliter for each isolate. Results obtained demonstrated that there is significant differences of sporulation between isolates. In fact, we distinguish 3 isolates groups. The first group is composed of Tunis and Bizerte, the second group Pont Bizerte and Fretissa. the last group is formed by the Algeria isolate.

Table 2: Number of conidia per milliliter of suspension issued from Tunis, Bizerte, Pont Bizerte, Fretissa and Algeria isolates.

Isolates	X
Tunis	20.33 a*
Bizerte	19.67 a
Pont Bizerte	32.33 b
Fretissa	22.67 b
Algeria	11 c

x: Values followed by the same letter (s) are not significantly different at P=1%.

To study the virulence of the different isolates, the durum wheat cultivars were inoculated separately with the 5 septoria isolates and were successfully infected. To assess cultivar reaction to septoria isolates, we considered a cultivar susceptible when the PSA was higher than 20%. The analysis of variance revealed highly significant differences both in disease reactions of the wheat cultivars and in virulence of septoria isolates (Table 3). More important, however, was the high by significant cultivars x isolates interaction which demonstrated physiologic specialization of the pathogen.

Table 3: Mean square effects of the four evaluation methods on the eight differential durum wheat varieties.

Method of evaluation	Source of variation	Mean square
LII (1)	isolate	0.2489**
	variety	0.1116**
	iso.x var.	0.0298**
PD (2)	isolate	21.7300**
	variety	17.2900**
	iso.x var.	2.5930**
PAS (3)	isolate	0.2442**
	variety	0.1127**
	iso.x var.	0.0294**
CR (4)	isolate	0.0442*
	variety	0.0103**
	iso.x var.	0.0023**

**: significant at 1%

*: significant at 5%

(1): linear infection index (%)

(2): pycnidia density

(3): percentage of attack severity

(4): chlorophyll rate (mg chl/g dried weight)

In fact, for LII and PAS, we distinguished 3 classes of virulence types (Table 4). The first class included the Bizerte isolate, the second, Algeria isolate and the third class contains by Pont Bizerte, Tunis and Fretissa isolates.

For the PD criterion, isolates were grouped into 2 classes (Table 4). The isolates of Tunis, Fretissa and Pont Bizerte were the most virulent, those of Bizerte and Algeria were less virulent.

For the CR criterion, isolates virulence demonstrated that there were 3 classes (Table 4). In fact, Pont Bizerte and Bizerte isolates were the least virulent. The Fretissa and Algeria isolates formed the class of moderate virulence. However, Tunis isolate constituted the most virulent class.

To group the isolates into distinct races, the disease scores were divided into 3 classes for LII and PAS (Table 4) and into 2 classes for PD and CR. The fact that the PD and CR variables discriminate data in fewer classes than LII and PAS, indicate that the former provide less information (17).

Table 4: Classification of septoria isolates based on four evaluation method.

Isolates	Evaluation method			
	LII (1)	PD (2)	PAS (3)	CR (4)
Tunis	0.282 c	3.320b	28.7 c	0.035 a*
Fretissa	0.288 c	3.280 b	28.8 c	0.064 ab
Pollt Bizerte	0.254 c	3.480 b	24.9 c	0.069 b
Bizerte	0.053 a	1.460 a	5.6 a	0.071 b
Algeria	0.149 b	1.820 a	15.2 b	0.042 ab

(1) linear infection index

(2): pycnidia density

(3): percentage of attack severity

(4): chlorophyll rate (mg chl/g dried weight)

* - values followed by the same letter (s) are not significantly different at P=1%

It is noteworthy that isolate groups for morphologic and pathogenic characteristics didn't correlate. Table 3 shows a significant cultivar x isolate interaction which varied according to the evaluation method considered. Thus highly significant interactions for LII and PAS could be considered as physiologic specialization index of *Septoria tritici*. However, a significant interaction for PD and CR indicates only the difference between virulence and aggressiveness. The five isolates were classed into three groups indicating there are three races of *Septoria tritici*. The first included the races from Tunis, Fretissa and Pont Bizerte as highly virulent, the second from Algeria moderately virulent and the third group of Bizerte lightly virulent. To complete our study, we identified the cultivars reaction on the basis of the 3 septoria races suggested here (Table 5). It is noteworthy that among the eight wheat cultivars, Amal, CHEN'S'-CD 26406-3B-5Y-OM-16Y-OB and CHEN'S'-CD 26406-1B-1Y-2Y-OM-1Y-OM reacted similarly to all isolates.

Table 5: Virulence patterns of isolates of *Septoria tritici* on host wheat cultivars.

Virulence groups	Wheat cultivars							
	BD1	BD2	BD3	BD4	BD5	BD6	BD7	BD8
I	S*	S	R*	S	S	S	R	R
II	S	R	S	R	S	S	R	R
III	R	R	R	R	R	S	R	R

R*: resistant, less than 20% leaf area necrotic with few pycnidia;
S*: susceptible, more than 20% leaf area necrotic, moderate to dense pycnidial, coverage.

BD1: Razzak; BD2: Karim 80;
BD3: BenBécher 79; BD4: Badri;
BD5: Maghrebi 72; BD6: Amal;
BD7: CHEN'S'-CD 26406-3B+5Y-OM-16Y-OB;
BD8: CHEN'S'-CD26406-1B-1Y-2Y-OM-1Y-OM.
I: Tunis, Fretissa and Pont Bizerte isolates.
II: Algeria isolate.
III: Bizerte isolate.

Conclusion

Contrary to most reports dealing with physiological specialization of *Septoria tritici*, the present study shows clearly that the *Septoria* isolates interacted differentially with the durum wheat cultivars used as differentials. Isolates capable of such differential interaction with the host constitute true physiological races in the conventional sense and not more «aggressive races» (28). In fact, the latter may differ in virulence or «aggressiveness» but could not interact differentially with the host. Thus, we can distinguish three races of *Septoria tritici*. The first included the isolates of Tunis, Fretissa and Pont Bizerte as highly virulent, the second from Algeria moderately virulent and the third of Bizerte highly virulent. Cultivar reaction on the basis of the three *Septoria* races investigated showed that among the eight wheat cultivars, Amal is susceptible against all isolates but CHEN'S'-CD 26406-3B+5YOM-16Y-OB and CHEN'S'-CD 26406-1B-1Y-2Y-OM-1Y-OM were resistant to all isolates. The occurrence of distinct races of *Septoria tritici* suggests that breeding for resistance to the pathogen might not be as straightforward and requires an extensive and perpetual search for sources of resistance.

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NOTES TECHNIQUES

TECHNISCHE NOTAS

TECHNICAL NOTES

NOTAS TÉCNICAS

Ploidy Variation in Hybrids from Interploid 3x X 2x Crosses in *Musa*

J. O. Osuji, D. Vuylsteke & R. Ortiz¹

Keywords : Aneuploids - Banana - Breeding - Cytogenetics - Plantain - Ploidy manipulations

Summary

Hybrids were obtained after *in vitro* germination of embryos from interploid crosses between triploid 'French' plantain cultivars (*Musa* spp. AAB group) 'Ntanga 2' and 'Bobby Tannap' with diploid banana (*Musa acuminata* subsp. burmannicoides) 'Calcutta 4'. Cross-pollinated bunches were harvested at full maturity and ripened with acetylene in a room for 4 days. Seeds were extracted from peeled ripe fruits by squashing. Embryos from the seeds were excised aseptically after 2 days and germinated *in vitro*. Seedlings were subsequently planted in early evaluation trials after acclimatising in the greenhouse. Chromosome counts were carried out on root tips of mature and maiden suckers to determine ploidy levels using a modified squashing technique. Counts showed that two of the hybrids were aneuploids (trisomics) with somatic chromosome number of $2n=2x+1=23$, one hybrid was diploid while the other two were tetraploids. Tetraploids are the most promising hybrids for the genetic improvement of plantains. Diploids are valuable material for further improvement of the plantain genome at this ploidy level. Trisomics provide means for further characterisation of the *Musa* genome and physical gene mapping in plantain and banana.

Résumé

Des hybrides ont été obtenus à partir d'embryons propagés *in vitro* de croisements interploïdes impliquant des cultivars triploïdes de plantain French (*Musa* spp. groupe AAB) 'Ntanga 2' et 'Bobby Tannap' avec la banane diploïde (*Musa acuminata* subsp. burmannicoides) Calcutta 4. Des régimes issus de pollinisation croisée ont été récoltés à pleine maturité et mûris à l'acétylène en chambre pendant 4 jours. Des fruits mûrs épluchés ont été écrasés pour l'extraction des graines. Deux jours après, les embryons ont été excisés des graines, en condition aseptique, et mis en germination *in vitro*. Les plantules ainsi obtenues ont été subséquemment plantées dans des essais d'évaluation précoce, après leur acclimatation en serre. Le comptage de chromosomes a été effectué sur des extrémités de racines de souches matures et de souches non fructifiées, à l'aide de la technique de squashing modifiée. Les comptages ont révélé que deux des hybrides étaient aneuploïdes (trisomie) avec un nombre $2n=2x+1=23$ de chromosomes somatiques, un hybride était diploïde avec un nombre $2n=2x=22$, tandis que les deux autres étaient tétraploïdes avec un nombre $2n=4x=44$.

Introduction

The tropical monocotyledonous genus *Musa* belongs to the family Musaceae and order Zingiberales (syn. Scitaminae) and comprises giant perennial monococious herbs (9). Out of the four sections of this genus namely *Rhodoclamis*, *Australimusa*, *Calimusa* and *Eumusa*, only *Eumusa* comprises edible crops such as plantains and bananas. These crops originated from two diploid parents *M. acuminata* (A genome) and *M. balbisiana* (B genome) through hybridisation and parthenocarpy.

Aneuploid plants are used for cytogenetic research to determine the localisation of genes within chromosomes, and to separate chromosomes from distinct genomes (2, 5). Aneuploid plants in *Musa* are mostly derived from triploid by diploid crosses (11). These

aneuploid plants may be of value for *Musa* breeding and genetics as shown earlier in wheat (7).

In addition to aneuploids, various levels of euploidy have also been observed to arise in embryos from triploid by diploid crosses (1, 11). Diploids, triploids and tetraploids are observed after *in vitro* germination of hybrid seeds. It is evident, however, that the frequency of triploids from such crosses after *in vitro* germination is least while the frequency of diploids is highest (11).

Despite the economic importance of plantain and banana, there have been very few investigations on the *Musa* genome. This is not the case with other crop plants such as tobacco (*Nicotiana tabacum*) (3), maize (*Zea mays*) (4, 8), wheat (*Triticum ocitiorum*) (7), or potato (*Solanum tuberosum*) (13). Recovery of

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aneuploids from products of *Musa* breeding will pave the way to further genome analysis of the *Musa* genus. Aneuploids will help to determine the relationship between the A and B genomes, and can be useful for physical mapping of important *Musa* genes.

Material and Methods

Mature triploid 'French' plantain cultivars 'Ntanga 2' 'Bobby Tannap' (*Musa* spp. AAB group) in anthesis were cross-pollinated with *M. acuminata* subsp. *burmannicoides* (Calcutta 4). Mature pollinated bunches were harvested and ripened at room temperature with acetylene in a room for 4 days. Ripe fruits were peeled and their seeds extracted by squashing. The collected seeds were air-dried. After 2 days, the seeds were sterilised in 0.5-0.75 % (w/v) sodium hypochlorite (NaOCl) for 15 min. The embryos, which are small (0.7 mm - 1 mm), were excised from the seeds with the aid of a stereomicroscope following procedures reported by Vuylsteke et al. (10). Excised embryos were cultured aseptically on a modified MS medium with macro- and micro-nutrients at half-concentration, but FeEDTA at full strength (10). This medium was supplemented with 3% sucrose, 2 mg l⁻¹ glycine, 0.5 mg l⁻¹ nicotinic acid, 0.5 mg l⁻¹ pyridoxin.HCl, 0.4 mg l⁻¹ thiamine.HCl, and 20 mg l⁻¹ ascorbic acid. The medium was solidified with 1.5 g l⁻¹ Gelrite (R). Aliquots of medium (20 ml) were dispensed in 15 x 2.5 cm glass test tubes, capped with cellulose stoppers, and autoclaved for 15 min at 121° C (1.05 kg cm⁻²).

Viable embryos germinated into seedlings that were acclimatised in the greenhouse and later planted in the field to allow normal plant development. Root tips were collected and immediately pre-treated for three hours with 0.002 M solution of 8-hydroxyquinoline at room temperature (27° C). This pre-treatment was followed by fixation of root samples in 1:3 acetic ethanol) for 12-18 hours at low temperature (4° C-8° C). Root tips were squashed under a drop of FLP orcein according to the method of Osuji et al. (6). Chromosome counts were carried out on a sample of 10 cells for each hybrid at magnifications of X 400 and X 1000 (oil immersion) using a Leitz Diaplan binocular microscope.

Results and Discussion

There was variation in the chromosome number of the different hybrids. Seedling 1518-4 was a diploid with somatic number $2n=2x=22$. Seedlings 1605-1 and 9722-1 were trisomics with the somatic chromosome number $2n=2x+1=23$ while seedlings 1187-8 and 8223-1 were tetraploids with the chromosome number $2n=4x=44$ (Figure 1 and Table 1).

Table 1. Ploidy levels of some Tropical *Musa* Plantain hybrids

Clone	Female parent	Male parent	Ploidy
1187-8	'Bobby Tannap'	Calcutta 4	$2n=4x=44$
1518-4	'Bobby Tannap'	Calcutta 4	$2n=2x=22$
1605-1	'Ntanga 2'	Calcutta 4	$2n=2x+1=23$
8223-1	'Bobby Tannap'	Calcutta 4	$2n=4x=44$
9722-1	'Bobby Tannap'	Calcutta 4	$2n=2x+1=23$

Calcutta 4 is *Musa acuminata* subsp. *burmannicoides*.



Figure 1. Chromosomes of plantain-banana hybrids obtained after triploid-diploid crosses: diploid 1518-4 with 22 chromosomes (a), trisomics 1605-1 (b) and 9722-1 (c) with 23 chromosomes, and tetraploid 8223-1 with 44 chromosomes (d). Scale bar = 10.2 µm.

Many aneuploids, which resulted from the crosses reported in this paper, were destroyed earlier because the primary objective of the breeding program was to produce hybrids that are resistant to black sigatoka disease (12). For example, from 1988 to 1990 about 23,600 hybrid seeds were obtained from 3x X 2x crosses between plantains and bananas, and 550 hybrid embryos were germinated and transferred to the breeding nursery. Most seedlings were aneuploids as shown by their gross abnormal foliage and stunted growth. Only 250 diploids, triploids and tetraploids were established in the field for agronomic evaluation (11). Thus, a high frequency of aneuploid *Musa* plants can be produced by interploidy 3x X 2x crosses.

Aneuploids may contribute significantly to the cytogenetic characterisation of the *Musa* chromosomes and genomes. Likewise, aneuploids will be valuable tools for physical mapping of genes in plantain and banana chromosomes. Knowledge on chromosome number, structure and behaviour may facilitate the manipulation of the *Musa* genome for its further improvement using conventional and new breeding tools.

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The Use of Golden Snail (*Pomacea* sp.) as Animal Feed in the Philippines

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Keywords : Golden snail meal - Animal feed - Snail

Summary

The golden snail is introduced to the Philippines in early 80's for culture as food source. This herbivorous snail, a voracious feeder of live and fresh plant materials become a serious rice pest. Its elimination in the ecosystems is impossible. To use them as animal feed is much better alternative for their control and more environmentally friendly than the use of chemicals. Thus, this mini review paper aimed to collate any existing information on the use of golden snail as animal feed. The different meal forms that can be extracted are golden snail meal (30% calcium and 15% crude pro-

tein), golden snail meat meal (62% crude protein and 3336 kcal/kg) and golden shell meal (35% calcium). Feeding trials indicate that golden snail meal can be a part of swine and chicken layer diets up to 15%. Golden snail meat meal can be a part of broiler chicken diet up to 12%. Feeding fresh and ground golden snail to ducks can replace 50% of their diet under total confinement system. Whereas, golden snail meat meal (75% of the diet) plus rice bran can be beneficially fed to tilapia. With the information collated, golden snail can be a promising animal feed in the Philippines.

Introduction

The golden snail or golden apple snail commonly called golden kuhol became popular to Filipinos in the early 80's as human food and source of income. Introduced to the country by private sectors from Florida, U.S.A. and Taiwan, it was commercially popularized and farmed in concrete tanks, ponds and other controlled environments.

Its scientific name is *Pomacea insularis* as reported by workers of Freshwater Aquaculture Centre, Central Luzon State University, Philippines (Cagauan and Yambot, (7) while Barcelo and Barcelo (4) used the name *Pila leopoldvilensis*. However, the International Rice Research Institute (IRRI) identified it as *Pomacea canaliculata* (7). FAO and the Department of Agriculture, Phil. (11) adapted the latter in their handbook for the integrated control management of the snail in a rice farm. All of them, however, are voracious feeders of live and fresh plant materials and with phenomenal reproductive capacity and fast growth rate.

The popularity of the golden snail had to the Filipino people brought a tremendous physical movement throughout the country. The golden snails were stocked in water ponds, concrete tanks and other rearing facilities. These escaped and found their way to water channels and eventually to ricefields. It was on the second half of the last decade that the farmers saw and felt the devastation made by the golden snails to

their rice plants. Majority of the farmers resorted to chemical control as immediate solution to the problem. However, the high cost of these inputs coupled with the hazards they pose to the users, draught animals and the environment, prompted the development of more practical strategies. Workers at IRRI, DA and Philippine Rice Research Institute (PHILRICE) recommended collection of snails and eggs clusters, use of traps or screen in water inlets, proper water management as control measures of golden snails (5, 13). Others looked at the potential usage of golden snail as animal feedstuffs supplement. Thus, this paper aimed to discuss its extraction rate, nutrient composition and its level of inclusion in the animal's diet.

Extraction rate

The different meal forms that could be derived from golden snail are: cooked and uncooked golden snail meal (GSM), cooked golden snail meat meal and golden snail shell meal. The extraction rate of cooked and uncooked GSM are almost the same, with a mean value of 20.6 and 20.8%, respectively (unpublished data). However, other feedstuffs revealed relatively lower extraction rate, especially golden snail meat meal with a mean value of 4.7% while golden snail shell is about 16.6%. Therefore, the golden snail meal could be divided into a golden snail meat meal and golden snail shell meal by 22 and 78%, respectively.

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Nutrient composition

Golden snail meal. The nutrient composition of GSM for cooked and uncooked (8) are presented in Table 1. Uncooked GSM had crude protein (CP) about 2.5% higher than the cooked GSM with a mean value of 14.62%. This could be attributed to possible destruction of some protein of the meal due to cooking. Nevertheless, both meals showed relatively higher CP value when compared to snail meal, *Paludina angularis* (11.7%) as reported by Gerpacio and Castillo (12). Gross energy (GE) values, however, were quite low, 605.61 and 671.45 kcal/kg for cooked and uncooked GSM, respectively. Except for the ash content, other nutrient fractions such as ether extract (EE), crude fiber (CF) and nitrogen-free extract (NFE) were practically low. The ash content of cooked and uncooked GSM was 81.07 and 78.40%, respectively. Further evaluation of its mineral value showed the following: 30.87% calcium (Ca) and 0.3% phosphorus (P) for cooked GSM while the uncooked was slightly lower, 28.55% Ca and 0.26% P. This proved that this GSM can be a good source of Ca and P although there is much to desired on its ratio.

Table 1
Nutrient composition of different feedstuffs derived from golden snails ⁽¹⁾

Item	Golden Snail Meal (Cooked)	Golden Snail Meal (Uncooked)	Golden Snail Meat Meal	Golden Snail Shell Meal
DM, %	90.30	89.90	86.10	98.60
GE, kcal/kg	605.61	671.45	3336.27	
	%DM			
CP	14.62	17.15	62.48	4.30
EE	0.88	0.56	3.48	0.50
CF	3.43	3.45	4.65	3.00
NFE		0.44	13.36	0.90
Ash	81.07	78.40	16.03	91.30
Ca	30.87	28.55	3.40	35.05
P	0.30	0.26	1.22	0.01

¹ Analyzed by the procedures of AOAC (2); adapted from Catalma et al. (8).

Golden snail meat meal. Contrary to the previous feed materials from golden snail, meat meal showed better CP and GE values (Table 1). Similar to other

feedstuffs from animal tissues, CP content was about 62.48%. This could be compared to the CP value of Peruvian fish meal, 61.2% and meat meal, 66% (12). However, the CP values of raw and cooked golden snail meat meal obtained by Barcelo and Barcelo (4) were slightly lower (53.2 and 52.2%). Likewise, as an excellent source of energy, it had a GE value of approximately 336.3 kcal/kg. Other nutrient components also indicated an appreciable level of EE, NFE, and Ca. Its Ca and P contents were 3.40 and 1.22%, respectively, and Ca:P ratio of 2.8:1. These data implied that the golden snail meat meal is a potential source of organic as well as inorganic matter compared to other feed extract golden snail.

Golden snail shell meal. The nutrient composition of the golden snail shell meal is also shown in Table 1. Its inorganic or ash content was very high, 91.30%. This feedstuff could be an excellent source of Ca (35.05%) like that of oyster shell meal (32.3% Ca) (12). Other nutrient fractions of this meal (CP, EE, NFE and CP) were considered trace which came from the remains of the snails tissue during processing.

Feeding studies (summarized in Table 2)

Swine. Feeding trials were conducted on growing-finishing swine (8) utilizing uncooked GSM. The uncooked GSM was supplemented to swine diet at 0, 5, 10 and 15% levels. The trial was started at a mean weight of 24.2 kg and ended at a mean weight of 87 kg. All the response criteria, average daily gain (ADG), average daily feed consumption (DFC) and average feed to gain ratio (FGR), showed no statistical differences among the different treatment means. The range of data obtained were: ADG, 0.5 - 0.6 kg; DFC 2.4 - 2.4 kg; and FGR, 3.9 - 4.4. The results suggest that inclusion of uncooked but fresh GSM in the swine diets up to 15% is beneficial, however, cooking the GSM is recommended to prevent any contaminants.

Poultry. Feeding of uncooked GSM was also tried in native chicks (9). A 10% inclusion in a simple chick's diet showed a 31% increased in total gain in weight and 35% improvement in feed efficiency than the chicks fed without GSM. Crushed golden snail was also fed to White Leghorn chicken layer as supple-

Table 2
Summary of feeding trials using golden snail and its different meal forms

Animal	Meal form	Type of diet	Reference
Growing-finishing swine	uncooked golden snail meal	up to 15% replacement of mixed feed	Catalma et al. (8)
Native chick White Leghorn chicken layer Broiler chicken Duck	uncooked golden snail meal	10% inclusion in the diet	Catalma et al. (9)
	crushed golden snail	20 g bird'd' supplementation	Ancheta et al. (1)
	raw and cooked golden snail meal	12% inclusion in the diet	Barcelo and Barcelo (4)
Duck	crushed golden snail	equal ratio of snail, rice bran, broken corn	Tacio (15)
	whole golden snail	2:1 snail and rice bran	Serrano (14)
		<i>ad libitum</i> snail and minimal rough rice	Aquino (3)
Tilapia	golden snail meat meal	25-50% replacement of mixed feed	Datuin et al. (10)
		75-100% snail meat meal + rice bran	Cagauan and Doria (6)

ment to commercial laying mash (1) Results showed that 20 g bird⁻¹d⁻¹ of crushed golden snail gave a 88% mean hen-day egg production rate as compared to zero supplementation which gave a 84.3%. A follow-up study was made to utilize ground golden snail as replacement in the diet of White Leghorn chicken layer (9). The mean hen-day egg production rate was 84% for the layer without supplementation and 72% for layers fed with a diet either 11.11 or 25% replacement. The other response criteria, DFC, FGR, average shell thickness and albumen height were not statistically different except for egg color intensity. Higher value of eggs from layers fed with a diet of ground golden snail was obtained.

The feeding value of golden snail meat meal was also tried in broiler chicken (4). Raw snail meat meal and cooked snail meat meal were compared to fish meal, the incorporation in the diet was 11.9, 12.2 and 10%, respectively. The CP of the different diets was 21 %. Results showed that birds fed the fish meal had the highest FGR (2.0) followed by the birds fed the cooked and raw golden snail meat meal, 2.3 and 2.4, respectively. The gain in weight of the birds fed the cooked golden snail meat meal had comparable gain in weight with the birds fed the fish meal.

Ducks are the most common poultry species being utilized by the farmers in controlling the population of golden snail in the ricefields. Both the Mallard (*Anas platyrhynchos*) and Muscovy (*Cairina moschata*) ducks are being used although the former is being preferred by the farmers. For the farmers to utilize the ducks in controlling the golden snail population, they pasture the ricefields before the rice transplanting, 30-45 days after transplanting and after rice harvest. Under the total confinement system, ducks are also being fed with golden snail. Fresh ad crushed golden snails are mixed with rice bran and broken corn at a ratio of 1.1: 1. The diet resulted in a 60-70% egg production rate of Mallard ducks (15). Serrano (14) observed the actual farm practice of 2:1 of fresh golden snail and rice bran. The work of Aquino (3) used minimal rough rice and *ad libitum* fresh golden snails

resulted in 68% egg production rate. Another feeding system used was combination of golden snail and commercial duck layer feeds at a ratio of 1: 1-3 which resulted in optimum egg production rate and low production cost (10).

Tilapia. Cagauan and Doria (6) conducted a 87-day feeding study on Nile tilapia (*Oreochromis niloticus*) using golden snail meat meal or fish meal plus rice bran. Results indicated that pure golden snail meat meal and 3:1 golden snail meat meal and rice bran diets gave better growth rate of 0.12 g/day than 1: 1, 1: 3 golden snail meat meal and rice bran and 1:3 fish meal and rice bran which gave growth rate of 0.09 to 0.1 g/day.

Conclusion

Based on literature reviewed, the following conclusions could be derived:

1. Extraction rate of golden snail meal is 21%. The golden snail meat meal and golden shell meal has 22 and 78%, respectively.
2. Golden snail meal is rich in Ca (30%) and CP (15%).
3. Golden snail meat meal is a proteinaceous concentrate with 62% CP. It also possess a high energy value, 3336 kcal/kg. This feedstuff could replace possibly meat meal or fish meal in animal's diet.
4. Golden snail shell meal is mainly Ca-source feedstuff, 35%. This feedstuff could replace oyster shell meal in animal's diet.
5. Initial results showed that golden snail meal could be a part of swine and chicken layer diets up to 15%. While golden snail meat meal could be a part of broiler chicken diet up to 12%.
6. Feeding fresh and ground golden snail to ducks could replace 50% of their diet under total confinement system.
7. Feeding tilapia with golden snail meat meal at 75% of the diet in combination to rice bran is beneficial.

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**51ste Internationaal
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Zal plaats vinden op dinsdag 4 mei 1999 aan de Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen, Universiteit Gent (België).

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**Alle briefwisseling dient gericht te worden aan Prof. Dr. ir. P. De Clercq,
Vakgroep Gewasbescherming, FLTBW, Universiteit Gent, Coupure Links 653, B-9000 Gent (België),
e-mail: patrick.declercq@rug.ac.be, tel. 32 (0)9 264.61.58, fax 32 (0)9 264.62.39.**

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Recent Developments in the Nutrition of Herbivores

Proceedings of the IVth International Symposium on the Nutrition of Herbivores
Clermont-Ferrand (France) September 11-15, 1995.

Edited by M. Journet, E. Grenet, M.-H. Force, M. Theriez and C. Demarquilly

Size : 16,5 x 24 cm, 622 pages, 1995. Price : 300 BEF.

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Résumé. Rôle des herbivores dans le maintien d'une agriculture pérenne. Principes et pratiques - Quelques conséquences; T.J. Maxwell, J.A. Milne.

Role of herbivores in functions in which economic value is difficult to quantify.

Résumé. Rôle des herbivores dans les fonctions difficiles à évaluer économiquement; E.R. Orskov, E.F. Viglizzo.

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Résumé. Influence des conditions socio-économiques sur l'alimentation et la conduite des herbivores dans les pays tempérés; J.D. Oldham, S. Tamminga.

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Résumé. Sélection et stratégie d'affouragement des animaux sur parcours. Relation avec la variabilité spatiale et temporelle; P.J. O'Reagan, J. Schwartz.

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Grassland farm systems for sheep production.

Résumé. Production ovine en systèmes herbagers; G.W. Sheath, M. Theriez, G. Caja.

Feeding systems for draught ruminants on high forage diets in some African and Asian countries.

Résumé. Systèmes d'alimentation à base de fourrages pour les ruminants de trait dans quelques pays africains et asiatiques; R.A. Pearson.

Feeding systems for horses on high forage diets in the temperate zone.

Résumé. Systèmes d'alimentation à base de fourrages pour les chevaux en zone tempérée; D. Micol, W. Martin-Rosset.

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Future areas of research and expected advances in the nutrition of herbivores.

Résumé. Nouveaux domaines de recherche et retombées attendues pour la nutrition des herbivores; L.P. Milligan, M. Journet, W.J. Maeng.

Les réserves fourragères

II. Les pailles et leur valorisation

Fiches techniques d'élevage tropical (ressources alimentaires)

Fiche n° 2 - 1994; 8 pages, 5 photos couleurs, 4 tableaux, format DIN A4

CIRAD-EMVT - B.P. 5035. F 34032 Montpellier Cedex 1 - Fr. - France

Après avoir rappelé la différence entre « paille » et « foin », la fiche décrit le stockage en meule et l'utilisation ainsi que la valeur fourragère de ces pailles. Celle-ci peut être améliorée par traitement à l'ammoniac, assez complexe en réalité, ou par l'urée ce qui est plus recommandable et relativement facile (1 litre de solution d'urée à 5% par kilo de paille). La valeur énergétique et le taux de matières azotées digestibles sont fort améliorés par le traitement à l'urée. Deux exemples de coûts sont donnés. La constitution de réserves fourragères, leur amélioration éventuelle et leur utilisation rationnelle sont vivement recommandées par les auteurs, à juste titre.

J.H.

Les réserves fourragères

III. L'ensilage

Fiches techniques d'élevage tropical (ressources alimentaires)

Fiche n° 3 - 1994; 8 pages, 5 photos couleurs, 5 tableaux, format DIN A4

CIRAD-EMVT - B.P. 5035. F 34032 Montpellier Cedex 1 - Fr. - France

Cette troisième fiche sur les réserves fourragères décrit évidemment les fourrages ensilables, les processus fermentaires, les techniques et les types de silo (silo-taupinière ou silo-meule, silo-tranchée ou silo-fosse, silo-couloir, silo-tour, balles rondes enrubannées). On y rappelle très utilement les facteurs de réussite : plantes riches en sucres, hachées et tassées, non souillées par de la terre, travail effectué en deux jours au maximum, silo fermé hermétiquement. La conclusion des auteurs anonymes est la bonne : « L'ensilage accompagne un certain niveau d'intensification. C'est une technique de conservation particulièrement adaptée aux exploitations mécaniques comportant de gros effectifs de ruminants et visant à une production hautement valorisée. ».

J.H.

L'installation de biogaz

Etude et Détails d'Installations simples

L. Sasse, Format 17,8 x 24 cm, 90 pages, 59 figures, 1 annexe de formules. Edt. Friedr. Vieweg & Sohn, Braunschweig / Wiesbaden, Allemagne.

Cette édition française est une version remaniée des anciennes versions en allemand, anglais et espagnol. Elle contient notamment des données supplémentaires sur l'unité du digesteur avec l'étable, l'installation à cloche flottante et son joint hydraulique, et le couvercle. L'ouvrage devrait permettre d'éviter que des erreurs trop fréquentes soient encore commises.

Les sept chapitres traitent successivement de l'intérêt et du coût de l'installation, du processus de digestion, des types d'installations, du dimensionnement, de la conception, de l'utilisation, ainsi que de l'étude et de l'exécution.

Les très nombreux schémas, extrêmement clairs et simples, rendent ce petit ouvrage très concret et aisément compréhensible pour tous les développeurs. A recommander.

J.H.

Cuirs et peaux bruts tropicaux

A.H. Robinet.

Format 12 x 17 cm, 168 pages, très nombreuses photographies dont plusieurs en couleurs, dessins, schémas et tableaux abondants.

Collection Le Technicien d'Agriculture Tropicale n° 31, Ed. Maisonneuve et Larose, Paris, 1995. Prix : 77,81 FF. Frais de port compris.

Les zootechniciens et les vétérinaires sont, tôt ou tard, confrontés à des questions, relatives aux cuirs et peaux sans y être vraiment préparés par leurs études. Ce petit ouvrage, dans une collection dont la réputation n'est plus à faire, permet dorénavant à chacun de ne plus hésiter devant les termes techniques et de comprendre pourquoi certaines attitudes ou interventions sont à recommander ou à éviter.

En cinq chapitres (Origine et structure de la peau – Conservation et conditionnement des cuirs et peaux bruts – Les défauts des cuirs et peaux bruts – Le classement – Négoce, formation des prix et recherche de la qualité), l'auteur couvre réellement tout le secteur. Le glossaire permet aisément de préciser la terminologie professionnelle. L'examen de l'intéressante bibliographie montre qu'il n'y a plus eu de livres consacrés aux cuirs et peaux depuis une vingtaine d'années, après la référence classique de L. Mann (1951 et 1954). Tout plaide en faveur de l'acquisition d'un tel ouvrage.

J.H.
Mai 1996

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158 pages, 65 FF = 18 FF frais de port.

Tant que les populations rurales des zones tropicales continueront à croître de manière exponentielle et à cuire leurs aliments en utilisant du bois ou du charbon de bois, des solutions devront être trouvées au problème de la déforestation.

L'énorme pression démographique qui existe au niveau du Burundi, rend ce problème particulièrement aigu dans ce pays où, à cause du relief très accidenté, la disparition des arbres se traduit automatiquement par une érosion considérable et par une baisse sensible de la fertilité des sols.

La mise en place en 1979 d'un projet forestier national a permis de stopper la déforestation au Burundi et d'inverser progressivement la tendance. Financé par la Banque Mondiale et le Fonds d'Aide et de Coopération ce projet a été réalisé partiellement par les Volontaires du Progrès.

Le livre de Christophe Gasc et Clément Mathieu « Les Pépiniéristes privés au Burundi, vers une professionnalisation possible de l'agroforesterie » rend compte de l'évolution de ce projet. Outre les aspects techniques liés à la production d'essences ligneuses, cet ouvrage analyse également les contraintes socio-économiques et les diverses phases nécessaires pour passer progressivement d'un système assisté à un système autonome basé sur l'installation de pépiniéristes privés.

Cette expérience peut certainement inspirer tous les agents du développement qui se trouvent confrontés à la mise en place de systèmes de lutte contre la déforestation dans des situations similaires dans d'autres régions tropicales.

G. Mergeai
10.01.97

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