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Breaking of seed dormancy in three Dicotyledoneae weed species by plant growth regulators

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Abstract

Seeds of the dicot weeds *Arctotheca calendula*, *Emex australis* and *Raphanus raphanistrum* were used to determine its germination response to three plant growth regulators in an incubator at 20 oC with a 12-hour day/night cycle. Cumulative germination of *A. calendula* seeds was not improved by any of the chemicals used. Germination of *E. australis* was significantly increased at 3-7 days by an application of 1 mg ℓ^{-1} gibberellic acid, with similar results for both 30 mg ℓ^{-1} hydroxylamine and 0.3 mg ℓ^{-1} kinetin at 0-3 days. The germination of *R. raphanistrum* was, apart from the 0-3 day incubation period, significantly improved at all other incubation periods when 100 mg ℓ^{-1} gibberellic acid was applied.

Introduction

Dormancy is a property of many weed seeds that enables them to survive conditions hazardous to plant growth and to germinate at some later time or in some other place. Seeds may persist in the soil for many years because of dormancy and germinate when conditions are favourable for seedling survival through to maturity (Duke, 1985). Bewley & Black (1982) stated that the ability of growth regulators, when applied to seeds, to release seeds from dormancy and promote germination is particularly interesting as it gives an indication to possible dormancy mechanisms.

Several chemicals, when applied to dormant seeds, might cause them to germinate. Although the seed of numerous species mostly respond to one or more of these chemicals, large differences are found between species (Corns, 1959; Bewley & Black, 1982; Metzger, 1983; Hurtt & Taylorson, 1986). Little is however known with regard to the response of some troublesome *Dicotyledoneae* (dicot) weed species in the Western Cape to these chemicals. Floral variation and other reproductive morphology provide the basis for dividing the flowering plants into two major classes: the class *Magnoliopsida* (dicots) and the class Liliopsida (monocots).

Povilaitis (1956), stated that the application of chemicals to the soil to stimulate weed seed germination might be an alternative method of weed control and could result in the weed population being destroyed in one season rather than by repeated annual applications of herbicides.

Generally, selective herbicides are registered for either broadleaf (dicot) or grass (monocot) weed control because of different physiological responses between the two classes. It is therefore botanically useful to distinguish anatomically and physiologically between dicot and monocot weeds.

The informal name dicot refers to the presence of two embryonic leaves (cotyledons) in the seed. The stomata are scattered in leaves of dicot plants. Most dicot leaves have netted venation, meaning they have one or a few prominent mid veins from which smaller minor veins branch into a meshed network (Moore et al., 1998). In dicots, flower parts usually occur in multiples of four or five. Pollen usually has three furrows or pores. The primary vascular bundles in the dicot stem are arranged in a ring. True secondary growth with vascular cambium is commonly present in dicots (Moore et al., 1998).

The objective of this study was to evaluate the effect of three growth regulators to break dormancy and enable simultaneous germination of the dicot weeds *Arctotheca calendula*, *Emex australis* and *Raphanus raphanistrum*.

Materials and Methods

Seeds of *A. calendula*, *E. australis* and *R. raphanistrum*, collected during the year 2000 at Langgewens Experimental Farm in the Swartland wheat producing area of South Africa and stored at room temperature (15-25 ºC), were used in this germination study.

To determine the germination response of the above-mentioned weed species to three plant growth regulators, 100 seeds of each species were placed on Whatman's filter paper in 9.5 cm diameter petri dishes and moistened with 5 mℓ of the test solutions gibberellic acid, hydroxylamine (auxin) or kinetin (cytokinin), respectively. Subsequently, the petri dishes were then sealed with parafilm and placed in an incubator at 20ºC with a 12 hour day/night cycle.

The following test solutions were used:

Gibberellic acid

Gibberellic acid (purity > 90%) was tested at concentrations of 0 (control), 1 mg ℓ^{-1}, 10 mg ℓ^{-1} and 100 mg ℓ^{-1}. Each test solution also contained 2% (v/v) acetone and 0.1% (v/v) oxysorbic (Tween) which assisted with the dispersal of the test compounds (Metzger, 1983). Test solutions were adjusted to pH 4.8 using 6N KOH.

Hydroxylamine (auxin)

Hydroxylamine concentrations of 0 (control), 3 mg ℓ^{-1}, 10 mg ℓ^{-1} and 30 mg ℓ^{-1} were used. Each concentration were adjusted to pH 7.3 using NaOH and made up to 1ℓ with distilled water as described by Esashi et al., (1979).

Kinetin (cytokinin)

Kinetin concentrations of 0 (control), 0.2 mg ℓ^{-1}, 0.3 mg ℓ^{-1}, 0.5 mg ℓ-1 were used. Each quantity was dissolved in 10 mℓ of slightly heated 0.5N NaOH before diluting with distilled water and made up to 1ℓ with distilled water (Igbinnosa & Okonkwo, 1992).

The germination was assessed by emergence of the radicle and determined after 3, 7, 10 and 14 days of incubation. With the tetrazolium test, the ugerminated seeds were categorized as either viable or dead (Wood et al., 1997). The germination percentage was based on the total number of seeds germinated as opposed to the total number of viable seeds tested. All treatments were replicated twice in a factorial design.

Statistical Analysis

Data were subjected to analysis of variance to assess the effect of different chemical concentrations on the germination of three weed species. The data were analysed using SAS (Statistical Analysis Systems, 1987).

Results

Arctotheca calendula

The germination rates of *Arctotheca calendula* were significantly affected by both the period of incubation and concentration of the chemicals used, but not by chemicals as a main factor (Table 1). None of the *A. calendula* seeds germinated during the first three days (0-3 day period) of incubation at any of the chemical treatments tested, while an average of 5.4%, 8.8% and 6.7% germinated during the 4-7 day, 8-10 day and 11-14 day periods of incubation, respectively. These results are in agreement with those reported previously at different temperature regimes (Manoto et al., 2004).

Results also showed a significant ($p \leq 0.05$) chemical x concentration x period interaction, indicating that the response of *A. calendula* to the

Table 1 Germination response (%) of** Arctotheca calendula **to three chemicals at four concentrations, over a period of 14 days at 20 °C.

			Periods				
Weed species	**Chemical**	**Concentration**	**0-3 days**	**4-7 days**	**8-10 days**	**11-14 days**	**Mean**
Arctotheca calendula	Gibberellic acid	0mg ℓ^{-1} 1mg ℓ^{-1} 10mg ℓ^{-1} 100mg ℓ^{-1}	0 e 0 e 0 e 0 e	22.5 a 2.5 de 2.5 de 0 e	5 cde 0 e 2.5 de 5 cde	5 cde 0 e 12.5 abcde 2.5 de	8.1 a 0.6 c 4.4 ab 1.9 bc
Mean	3.8						
	Hydroxylamine	0 mg ℓ^{-1} 3 mg ℓ^{-1} 10 mg ℓ^{-1} 30 mg ℓ^{-1}	0 e 0 e 0 e 0 e	7.5 bcde 0 e 2.5 de 0 e	20 ab 0 e 20 ab 7.5 bcde	2.5 de 7.5 bcde 10 abcde 17.5 abc	7.5 a 1.9 bc 8.1 a 6.3 ab
Mean	6.0						
	Kinetin	0 mg ℓ^{-1} 0.2 mg ℓ^{-1} 0.3 mg ℓ^{-1} 0.5 mg ℓ^{-1}	0 e 0 e 0 e 0 e	7.5 bcde 12.5 abcde 5 cde 2.5 de	5 cde 10 abcde 15 abcd 15 abcd	7.5 bcde 2.5 de 7.5 bcde 5 cde	5.0 abc 6.3 ab 6.9 ab 5.6 abc
Mean	6.0						
Mean			**0 b**	**5.4 a**	**8.8 a**	**6.7 a**	

LSD 't' Main effect chemical (P ≤ 0.05) = 2. 7 N.S.
LSD 't' Main effect concentration (P ≤ 0.05) = 3.1 *
LSD 't' Main effect periods (P ≤ 0.05) = 3.7 *
LSD 't' chemical x concentration (P ≤ 0.05) = 5.3 *
LSD 't' chemical x periods (P ≤ 0.05) = 6.3 N.S.
LSD 't' concentration x periods (P ≤ 0.05) = 7.3 N.S.
LSD 't' chemical x concentration x periods (P ≤ 0.05) = 12.7 *
* P ≤ 0.05 = Significant, N.S. = Not Significant.

different concentrations of chemicals used, differed with time. This is due to significant differences found for different gibberellic acid concentrations during the 4-7 day period and hydroxylamine concentrations during the 8-10 and 11-14 day periods of incubation (Table 1). Results were very inconsistent and did not show any clear trend. Therefore, it is possible that the above-mentioned significant interactions are thus most likely due to experimental error.

Cumulative germination figures (Figure 1) also showed that the germination of *A. calendula* seeds was not improved by any of the chemicals used. Cumulative germination of below 40% after 14 days of incubation, as also found in the experiment with different temperature regimes, indicated that *A. calendula* needed either very specific conditions for germination or that germination is prevented by an impermeable seed-coat or immature embryo (Gardner *et al*., 1985).

Emex australis

Germination rates of *E. australis* were significantly (p ≤ 0.05) affected by period of incubation, chemicals used and chemical concentrations used as main factors, as well as chemical x concentration and chemical x concentration x period interactions (Table 2). Mean values of 23.5% and 43.1% germination during the 0-3 and 4-7 day incubation periods, clearly indicated that seeds of *E. australis* used in this experiment were not dormant.

Although mean chemical x concentration values showed significant differences (p ≤ 0.05) between concentrations for all chemicals tested, mean germination was not significantly increased by any of the chemicals used. During individual periods of incubation, germination of *E. australis* was significantly increased due to the application of 1 mg ℓ^{-1} of gibberellic acid at 3-7 days, 30 mg ℓ^{-1} hydroxylamine at 0-3 days and 0.3 mg ℓ^{-1} kinetin at 0-3 days.

This resulted in slightly higher cumulative germination values for *E. australis* if treated with low concentrations (1 and 10 mg ℓ^{-1}) gibberellic acid

Figure 1: Cumulative germination of** A. calendula **due to (a) gibberellic acid, (b) hydroxylamine and (c) kinetin treatments.

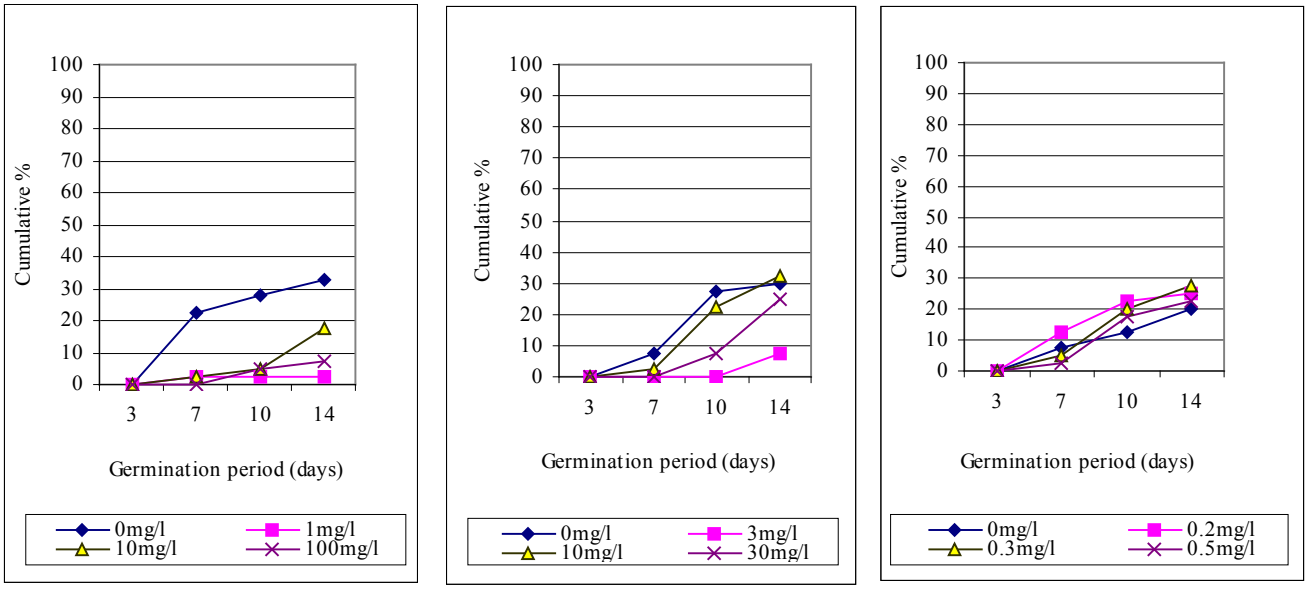


Table 2: Germination response (%) of** Emex australis **to three chemicals at four concentrations, over a period of 14 days at 20 °C.

			Periods				
Weed species	**Chemical**	**Concentration**	**0-3 days**	**4-7 days**	**8-10 days**	**11-14 days**	**Mean**
Emex australis	Gibberellic acid	0 mg ℓ^{-1} 1 mg ℓ^{-1} 10 mg ℓ^{-1} 100 mg ℓ^{-1}	22.5 defgh 12.5 fgh 12.5 fgh 2.5 h	37.5 bcde 60 ab 37.5 bcde 22.5 defgh	5 gh 5 gh 10 fgh 10 fgh	2.5 h 0 h 15 efgh 15 efgh	16.8 abc 19.4 a 18.7 abc 12.5 bc
Mean	16.9 b						
	Hydroxylamine	0 mg ℓ^{-1} 3 mg ℓ^{-1} 10 mg ℓ^{-1} 30 mg ℓ^{-1}	15 efgh 7.5 gh 17.5 efgh 50 abc	57.5 ab 12.5 fgh 67.5 a 45 abcd	2.5 h 17.5 efgh 2.5 h 0 h	2.5 h 10 fgh 5 gh 2.5 h	19.4 abc 11.9 c 23.1 a 24.4 a
Mean	19.7 a						
	Kinetin	0 mg ℓ^{-1} 0.2 mg ℓ^{-1} 0.3 mg ℓ^{-1} 0.5 mg ℓ^{-1}	17.5 efgh 27.5 cdefg 60 ab 37.5 bcde	50 abc 62.5 a 32.5 cdef 32.5 cdef	5 gh 7.5 gh 7.5 gh 0 h	0 h 0 h 0 h 10 fgh	18.1 abc 24.3 ab 25.0 a 20.0 abc
Mean	21.9 a						
Mean			**23.5 b**	**43.1 a**	**6.0 c**	**5.8 c**	

LSD 't' Main effect chemical (P ≤ 0.05) = 4.7 *
LSD 't' Main effect concentration (P ≤ 0.05) = 5.4 *
LSD 't' Main effect periods (P ≤ 0.05) = 7.1 *
LSD 't' chemical x concentration (P ≤ 0.05) = 9.3 *.
LSD 't' chemical x periods (P ≤ 0.05) = 12.3 *
LSD 't' concentration x periods (P ≤ 0.05) = 14.2 N.S.
LSD 't' chemical x concentration x periods (P ≤ 0.05) = 24.6 *
* P ≤ 0.05 = Significant, N.S. = Not Significant

or medium concentrations of hydroxylamine (3 and 10 mg ℓ^{-1}) and kinetin (0.2 and 0.3 mg ℓ^{-1}) (Figure 2). These treatments with hydroxylamine and kinetin resulted in cumulative values of more than 90% germination of *E. australis* after 14 days of incubation.

Raphanus raphanistrum

Germination of *R. raphanistrum* seeds were also significantly (p ≤ 0.05) affected by chemicals used, concentration rates and period of incubation as main factors (Table 3).

Although mean germination percentages for different incubation periods were generally low (less than 20%), significant interactions between concentration rates and chemicals used, resulted in high germination rates during specific incubation periods.

The application of gibberellic acid did not affect the germination of *R. raphanistrum* during the 0-3 day incubation period (Table 3 and Figure 3). At all other incubation periods, germination percentage were significantly (p ≤ 0.05) improved if 100 mg ℓ-1 gibberellic acid was applied. Hydroxylamine and kinetin did not have any effect. The germination of *R. raphanistrum* at all kinetin treatments increased with an increase in incubation period.

Cumulative values (Figure 3) confirmed the stimulating effects of gibberellic acid on the germination of *R. raphanistrum* seeds since the application of 100 mg ℓ-1 gibberellic acid caused more than 90% of the seed to germinate within 14 days of incubation, while kinetin also showed a stimulating effect at the highest concentration.

Figure 2 Cumulative germination of** E. australis **due to (a) gibberellic acid, (b) hydroxylamine and (c) kinetin treatments.

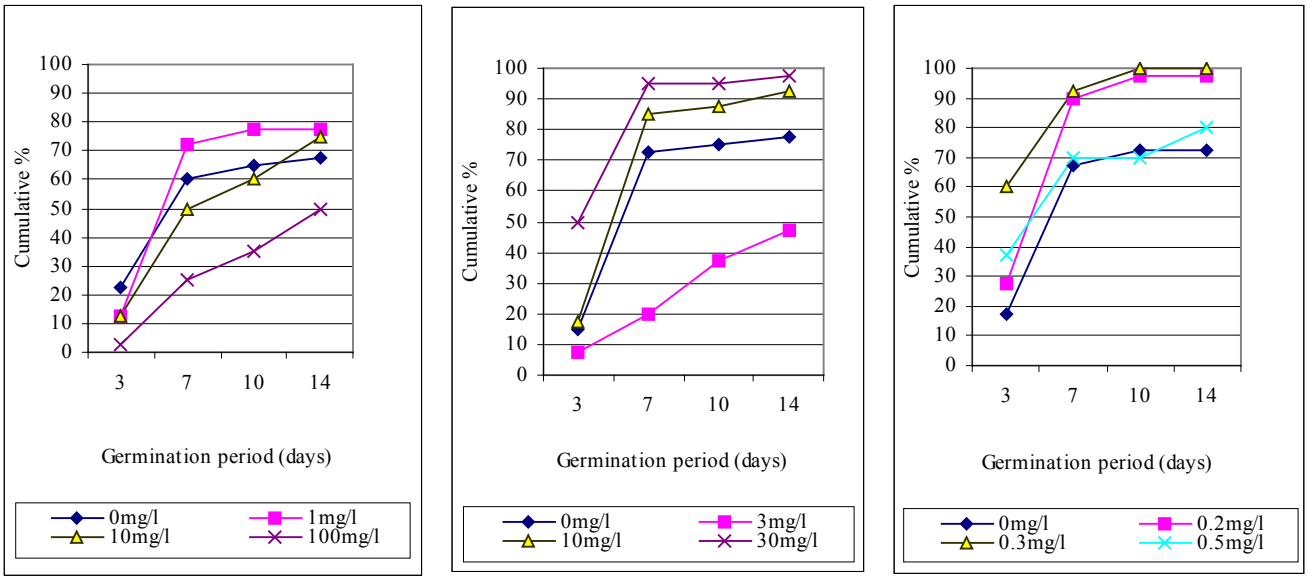


Table 3 Germination response (%) of *Raphanus raphanistrum* to three chemicals at four concentrations, over a period of 14 days at 20 °C.

			Periods				
Weed species	**Chemical**	**Concentration**	**0-3 days**	**4-7 days**	**8-10 days**	**11-14 days**	**Mean**
Raphanus raphanistrum	Gibberellic acid	0 mg ℓ^{-1} 1 mg ℓ^{-1} 10 mg ℓ^{-1} 100 mg ℓ^{-1}	7.5 fgh 2.5 h 12.5 efgh 2.5 h	0 h 0 h 7.5 fgh 22.5 cdefg	0 h 0 h 5 gh 40 bc	0 h 0 h 10 efgh 25 cdef	1.9 e 0.6 e 8.8 d 22.5 ab
Mean	8.4 a						
	Hydroxylamine	0 mg ℓ^{-1} 3 mg ℓ^{-1} 10 mg ℓ^{-1} 30 mg ℓ^{-1}	7.5 fgh 2.5 h 0 h 5 gh	0 h 0 h 5 gh 7.5 fgh	0 h 0 h 2.5 h 0 h	0 h 0 h 2.5 h 0 h	1.9 e 0.6 e 2.5 e 3.1 e
Mean	2.0 b						
	Kinetin	0 mg ℓ^{-1} 0.2 mg ℓ^{-1} 0.3 mg ℓ^{-1} 0.5 mg ℓ^{-1}	2.6 h 2.6 h 0 h 0 h	2.6 h 5.3 gh 0 h 0 h	10.5 efgh 15.8 efgh 16.7 efgh 25 cdef	13.2 efgh 13.2 efgh 19.4 cdefg 16.7 efgh	7.2 d 9.2 d 9.0 d 10.4 d
Mean	9.0 a						
Mean			**3.8 b**	**4.2 b**	**10.0 a**	**8.3 a**	

LSD 't' Main effect chemical (P ≤ 0.05) = 2.4 *
LSD 't' Main effect concentration (P ≤ 0.05) = 2.8 *
LSD 't' Main effect periods (P ≤ 0.05) = 3.1 *
LSD 't' chemical x concentration (P ≤ 0.05) = 4.9 N.S.
LSD 't' chemical x periods (P ≤ 0.05) = 5.3 *
LSD 't' concentration x periods (P ≤ 0.05) = 6.2 N.S
LSD 't' chemical x concentration x periods (P ≤ 0.05) = 10.7 *
* P ≤ 0.05 = Significant, N.S. = Not Significant

Discussion

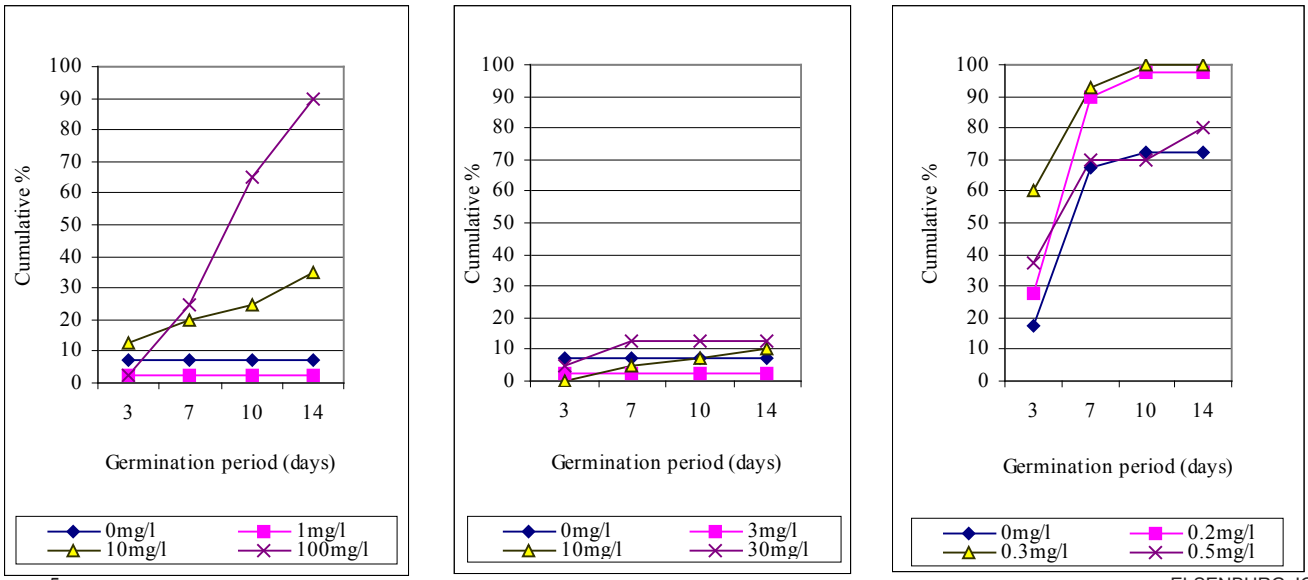
No chemical proved to be successful in stimulating the germination of all species tested, but individual weed species did respond to specific concentrations of the chemicals tested. This corresponds with earlier findings by Murdoch & Carmona (1993), who investigated ways to deplete seed banks by stimulating seeds to germinate.

Germination values of below 40% for *A. calendula* for all treatments tested after the 14 day incubation period, indicated that seeds of this species were in a dormant state and that this dormancy was most probably not due to the shortage of growth stimulators such as gibberellic acid, kinetin or hydroxylamine. These results support earlier findings by Mayer & Poljakoff-Mayber (1982). Ellery & Chapman (2000) showed that light may reduce dormancy in *A. calendula* seeds, while Chaharsoghi & Jacobs (1998) found that germination of this species can be enhanced by scarification.

Although low germination percentages for the control treatments of *R. raphanistrum* indicated that seeds of this species were also dormant, germination of this species was significantly (p ≤ 0.05) improved (or inhibited) by specific concentrations of one or more of the chemicals tested. Dormancy in this species, as also found by Harradine (1986), were therefore most probably the result of some chemical obstruction.

In contrast to this, high cumulative germination values of the control treatments of *E. australis* clearly indicated that seeds of this species used in the experiment were not dormant. Germination of *E. australis* seed were increased to nearly 100% after 14 days of incubation by high concentrations of hydroxylamine as well as low and medium concentrations of kinetin.

Figure 3 Cumulative germination of R. raphanistrum ***due to (a) gibberellic acid, (b) hydroxylamine and (c) kinetin*** treatments.



Conclusions

This study showed that different chemical concentrations might have an effect on breaking dormancy of different weed seeds. This is due to differing weed seeds that differ according to the state and longevity of dormancy as well as the physiological basis of dormancy.

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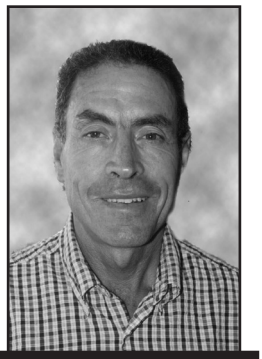
Questioning current milk pricing structures in the dairy industry in South Africa



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Introduction

The milk pricing system for dairy farmers in South Africa was previously controlled by the Dairy Board. Basically two pricing systems were used, i.e. one for fresh or liquid milk consumtion and another for industrial or processed milk. A higher price was usually paid for fresh milk. In 1983, the Dairy Board adopted the slogan “Milk is Milk” in an effort to pay all farmers a uniform price for their milk. Currently, milk prices are determined by the milk processors themselves resulting in various milk pricing structures. Payment for fresh milk is based on volume (liters) containing minimum levels of fat and protein percentages. The payment for milk for processing is based on the amount (kg) of fat and protein produced. The payment for fat and protein usually varies with a higher price for protein. Sometimes an additional premium is paid for protein to stimulate a higher protein production. Most milk processors also provide fresh milk to the market. Notwithstanding all the efforts to change, there are still real price disparities between fresh and industrial milk. Farmers still compare milk prices directly regardless of payment system. Individual milk prices will always differ because of different fat and protein percentages in milk and the amount of milk produced.

Fat and protein yield

Most dairy processors have found that the fat and protein percentage of the milk that is collected from farmers on a daily basis is lower than what it was 15 to 20 years ago. Various factors may have contributed to this, but it is probably because of the antagonistic relationship between milk volume and fat and protein percentages. This reduction in fat and protein percentages presents a problem for dairy processors as the production cost of most milk products is increased because of the lower contents. The increase in production costs is related to the higher transport and handling costs of milk with lower fat and protein percentages as more liters of milk are required to produce specific amounts of the same product. Fat and protein yields are determined by both the volume of milk produced and the percentage of fat and protein (Table 1).

Table 1. The effect of the volume of milk and the fat or protein percentages on fat or protein yield (kg fat/protein per cow per day)

Fat/ Protein%	Milk yield (liters/cow/day)						
	12.1	**14.6**	**17.7**	**21.4**	**25.9**	**31.4**	**38.0**
3.0	0.36	0.44	0.53	0.64	0.77	0.94	1.14
3.6	0.44	0.53	0.64	0.77	0.93	1.13	1.37
4.4	0.53	0.64	0.77	0.94	1.13	1.37	1.67
5.3	0.64	0.77	0.94	1.13	1.37	1.66	2.01
6.4	0.77	0.93	1.13	1.37	1.66	2.01	2.43

Fat or protein yields are increased by either increasing the volume of milk produced or the fat and protein percentage in the milk or by changing both the amount and contents of milk. Because the payment for milk is based on the amount of fat and protein produced, the same basic price is being paid for milk regardless whether the milk has a high or low fat and protein percentage. This causes contrasting interests for farmers and dairy processors. Dairy farmers tend to increase the volume of milk while dairy processors on the other hand, need milk containing higher fat and protein percentages to reduce the production cost of dairy products. Farmers increase the volume of milk through better feeding and genetics by increasing the average milk yield of cows in the herd or by milking a larger number of cows. The problem for processors is that less cheese is made per batch from milk containing less solids per volume. The size of milk vats in dairy plants is fixed and the amount of cheese that is produced from each vat depends mainly on the fat and protein percentage in the milk. The predicted Cheddar cheese production from a 100 kg of milk decreases from 13.7 to 9.5 kg when the fat and protein percentage of milk decreases from 5.50 and 4.20% to 3.50 and 3.00%, respectively. Because of the lower fat percentage, some 0.35 kg extra fat that would have been produced for butter, is lost. Prices for milk to be used for processing should encourage farmers to supply milk that contains high fat and protein percentages. The volume of milk should also be considered as that affects transport cost. The volume could be

increased by milking more cows in a herd. Dairy farmers will only adopt a different approach to milk components and yield if there is a financial incentive to provide the type of milk that processors require.

Penalising volume

Some countries have a milk pricing system based on prices paid per kg fat and protein with a penalty (a negative value) on the volume of milk produced. This is done presumably in an effort to encourage the production of milk containing more milk solids. It is, however, doubtful whether this practice will produce the desired results. In Table 2 the effect of a penalty on milk volume on the income of Holstein cows per lactation is shown.

Table 2: The effect of a negative price on the volume of milk produced on the income per lactation of cows in a Holstein herd

Parameters	Price	Production year		Change
		1983/84	1997/98	(%)
Milk (kg)	-5c/liter	5112	8360	+64
Fat (kg)	R5/kg	189	293	+55
Prot (kg)	R12/kg	172	269	+56
Income (R)		2753	4275	+55

Ways to increase the milk price

Milk pricing structures vary between different milk processors. The current milk pricing structure at Elsenburg is based on the amount of fat and protein produced with a bonus system to stimulate protein production. Deductions are made for transport cost based on the distance between the farm and the processing plant (starting at 30 km) and also milk quality based on somatic cell count and total plate count. According to this milk pricing structure, various options could be considered to increase the price of milk above a standard price (Table 3). This includes options such as milking more cows (Option 1), increasing the milk yield per cow (Option 2), increasing the protein percentage of the milk (Option 3) or milking an even larger number of cows (Option 4).

Table 3: The effect of different options on the milk price realised for a Jersey herd

Parameters	Options				
	Standard	1	2	3	4
Number of cows	10	82	82	82	460
Daily milk yield (kg)	15	15	19.5	15.0	15
Protein (%)	3.80	3.80	3.80	4.94	3.80
Protein volume premium (c/liter)	0	15	17	17	30
Milk price (c/liter)	200	215	217	217	230

By milking 10 cows, the price of milk for this herd is 200 c/liter. By increasing the number of cows in the herd to 82, the price of milk increases by 15 c/liter. It is increased by another 2 c/liter when the average milk yield in the herd increases from 15 to 19.5 liters/cow/day. The same response is obtained when the protein content of the milk increases from 3.80 to 4.94%. Increasing the average milk yield or protein percentage of the milk in a herd to such an extent over a short period of time, would imply a herd of high genetic merit that was previously grossly underfed. As the standard production level used in the example is typical for Jersey cows; both options 2 and 3 would only be achieved over a substantial period of time through improved genetic and management means. The results are also small, only a 2 c/liter increase on the current milk price. Increasing the number of cows in the herd to 460 resulted in another 15 c/liter increase in the protein bonus. Based on this milk pricing structure, the best way to improve the milk price would be to increase the volume of milk produced by milking more cows. For different milk pricing structures different options need to be considered. This makes recommendations regarding sire selection and the correct feeding and management programme to receive the best milk price very difficult.

Increasing the volume of milk

The variation in milk yield between cows is large and high milk yield levels are possible. Increasing the milk yield of cows is usually easy because it mainly involves feeding more and higher quality feeds. The amount of milk dairy cows produce is dependant on their total energy intake. The amount and quality of the forages (pasture, hay or silage) and supplementary concentrates determine the total energy intake of cows. The condition of the cows at calving also affects the amount of milk cows produce.

Increasing the milk composition of milk

It is difficult to increase the fat and protein percentages of milk by feeding as it involves contrasting feeding regimes. To increase the protein percentage in the milk, more energy in the diet is needed. This is usually supplied by feeding more or a higher quality concentrate mixture. By increasing the amount of concentrates in the diet, cows may start to ruminate less because of a shortage of fibre. This reduces the saliva production of cows resulting in a more acidic rumen. This reduces the number of acetic acid producing bacteria in the rumen and that results in milk having a lower fat percentage. Artificial buffers must then be included in the diet to protect the rumen against high acidity levels and a drop in fat percentage.

The total diet of dairy cows should always contain a minimum roughage level. For higher fat percentages more roughages or artificial buffers must be included in the diet to keep the acidity level in the rumen low. This effectively puts a limit on the maximum amount of concentrates in the diet. For cows on pasture, additional roughages like hay or straw are sometimes fed in an effort to increase rumination and to maintain or improve the fat percentage in the milk. This, however, could lead to a lower total feed and energy intake with a reduction in the milk yield and protein percentage. This could ultimately result in a reduced milk price and therefore milk income. According to the milk production results in a study where straw was fed additionally to cows on pasture, the net improvement in the milk price was small (less than 1 c/litre) without regarding the extra cost of feeding the straw.

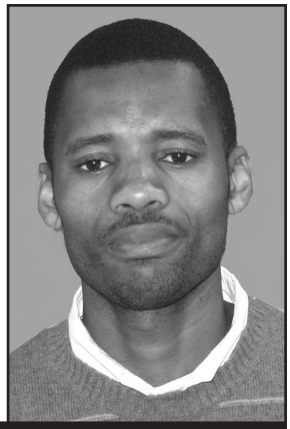
Sire selection

Based on heritability estimates, the genetic effect on milk production and milk composition in dairy herds is medium to high. The genetic relationship between milk volume and fat or protein yields is high and positive, while the relationships between volume and percentages are negative. Emphazing the volume of milk could result in milk containing less solids. This is to the disadvantage of dairy processors. With a high emphasis on fat and protein percentages, the volume of milk could be reduced to the disadvantage of farm income. A payment system based on prices paid per kg fat and protein provides little financial incentive to produce high solids milk. Sires are often labelled as high volume or high component bulls. Ranking sires according to their genetic income (based on a payment system for kg fat and protein), it is often found that bulls with high components rank lower than high volume bulls. This is because of lower fat and protein yields. Changing the genetic status of dairy cows in terms of milk volume and components is possible although difficult. This is dependant on a long term strategy and different sire selection criteria are needed both on farm and by AI companies.

Conclusions

The milk pricing structure of dairy processors affects the feeding and breeding programmes in dairy herds. A milk pricing structure based on fat and protein yields results in an increase in the volume of milk. This is in contrast to the requirement of dairy processors who need milk of high fat and protein percentages. A penalty on milk volume does not provide enough financial incentive to increase the fat and protein percentages in milk. The financial implications of feeding supplementary roughages or concentrates to change the fat or protein percentage in milk should be considered holistically. There is little incentive to feed straw to cows on pasture to improve the fat percentage in the milk if that results in less milk and a lower protein percentage and a reduction in the milk income. Milk pricing structures of dairy processors should include the volume of milk produced and the percentages of fat and protein in the milk. A sliding scale should be used emphazing higher fat and protein percentages. This will provide the financial incentive to farmers to adopt appropriate feeding, breeding and management strategies to supply a product that accords with the requirements of dairy processors.

Possible effects of the co-operative principles and co-operative action approach: a case of wine co-operatives



PHUMLANI S. MENTANI

lintroduction and background

Since its creation in 1895, the International Cooperative Alliance has been the final authority for defining cooperatives (Prakash, 2003) and for elaborating the principles upon which cooperatives should be based. Previously the Alliance had made two formal declarations on cooperative principles, the first in 1937 and the second in 1996 (Prakash, 2003). These two earlier versions, like the 1995 reformulation, were attempts to explain how cooperative principles should be interpreted in the contemporary world.

Throughout its history, the cooperative movement has constantly changed and there still a great potential for it to do so even in the future. Beneath the changes, however lies a fundamental respect for all beings and a belief in their capacity to improve themselves economically and social through mutual self-help.

However, this paper focuses on few cooperative principles that are believed to be influential pillars on how cooperative governance executes its practices. It was postulated in this paper that the benefits of the cooperative members may be subject to the efficient coordination of the influence of cooperative principles. The paper also tested how respondents perceive the collective action approach. The aim was to determine whether the sentiments on collective action still exist in well-established commercial cooperatives.

Data sources and research methodology

The target population of 50 wine cooperatives in the Western Cape were sent questioners by e-mail and personally and telephonically interviewed during May 2006, to obtain information about (1) beliefs on cooperative principles and (2) belief on collective action approach. Out of 50 cooperatives 28 cooperatives returned usable questionnaire. Each cooperative was represented by one respondent and attributed of different levels of believes. These believe were tested using an index from their scores on Likert type scales that show how they agree or disagree with the following statements:

(1) Wine cooperatives should accept any farmer who wants to join
(2) Wine cooperatives should practice one person, one vote
(3) The voting system of the cooperatives should be based on the member's shares
(4) Cooperative members should receive their returns based on their turnover in cooperative principle
(5) Wine cooperatives should support education in cooperative principle for members and the public
(6) Members receive benefits from doing business the cooperative way
(7) Farmers must stick together in order to get things done even if they have to give up some of their individual freedom
(8) An individual farmer can usually make better marketing decisions than a group of farmers
(9) Members of wine cooperatives have a competitive advantage in the market place (see table 1).

To promote accuracy of opinions, respondents were given neutral and no opinions responses. In measuring the believes the following Likert type scales were used;
1= strongly agree; 2 = agree; 3 = neutral; 4 = strongly disagree; 5 = disagree; and 6 = no opinion. To interpret the results the author relied on the literature, using various interpretations as justified by the New Institutional Economics theories.

Results and discussion

Many Cooperative scholars understand principles as iron-clad commandments that must be followed (Amin et al, 1996; Hanel, A, 1992; Nilsson, J 2001 etc.). It is believed that these principles provide standards of measurement that restrict and even prohibit certain actions while encouraging others. Prakash (2003) asserts that principles that forms the heart of cooperatives are not independent of one another and that they are subtly linked and eventually diminish when one of them is ignored. The rationale of these principles is to provide guidelines by which cooperatives put their values into practice and thereby, developing members in order to effectively contribute to the development of their business.

Evidently, the nature in which cooperative members contribute to their business is through collective action approach that primarily encourages the members to identify themselves and take personal interest in cooperative. One major reason for this approach is to benefit from the economies of scale practises. This argument incentives the organized functioning of a group of farmers into a single entity to realize their common interest.

However, Amin, N et al (1996) asserts that the collective action approach is likely to face high level of inefficiencies if the accomplishment of member's goals is not connected to organisational principles and moreover if cooperative principles diminishes the incentives for members to assume an ownership interest in the cooperative.

This implies that the benefits of the cooperative members may be subject to the efficient coordination of the influence of cooperative principles. Several statements were tested to solicit a general perspective of cooperative participants on cooperative principles as well as collective action approach. Irrespective of the current status of the wine cooperatives, evidence from the cooperative managers, directors and general managers on cooperative principles and collective action approach is indicated in the tables below.

Member beliefs in cooperative principles were assessed by using the first six principles stated in table 1. These beliefs suggest that respondents strongly support most cooperative principles. With the exception of the "open membership" principle, at least 77 percent of the respondents disagreed and/or strongly disagreed with it and also the one men one vote principle was clearly not supported by the respondents with 81 percent. Some other cooperative principles that involve acquisition of returns and shares, education and cooperative way of doing business were somewhat over contested with the majority of the respondents agreeing while a reasonable percentage became unsure and few had no opinions. The clearly contested principles with 77 and 81 percent suggest to a certain extent a potential to invoke challenges on governance should they strictly applied in wine cooperatives.

However, the importance of the benefit from the collective action approach was also shown by the above assessment. Evidently, in spite of the few respondents who were neutral and had no opinion, the majority of the participants supported the collective action approach. Out of three beliefs, namely, 1) Farmers must stick together in order to get things done even if they have to give up some of their individual freedom, 2) An individual farmer can usually make better marketing decisions than a group of farmers,

Table 1. Total Number of respondents on cooperative principles and collective action approach

	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree	No Opinion	Total
1.Wine cooperatives should accept any farmer who wants to join.	0	4	1	8	9	0	22
2. Wine cooperatives should practice one person, one vote	1	3	0	8	10	0	22
3. The voting system of the cooperatives should be based on the member's shares.	13	5	2	1	1	0	22
4. Cooperative members should receive their returns based on their turnover in cooperative principles	5	11	2	2	1	1	22
5. Wine cooperatives should support education in cooperative principle for members and the public	3	12	1	4	1	1	22
6. Members receive benefits from doing business the cooperative way	5	6	3	5	3	1	22
7. Farmers must stick together in order to get things done even if they have to give up some of their individual freedom.	6	11	1	3	0	1	22
8. An individual farmer can usually make better marketing decisions than a group of farmers	1	8	2	8	2		21
9. Members of wine cooperatives have a competitive advantage in the market place	1	4	8	7	2	0	22

Table 2 Percentage of respondents on cooperative principles and collective action approach

0%	18%	5%	36%	41%	0%	100%
5%	14%	0%	36%	45%	0%	100%
59%	23%	9%	5%	5%	0%	100%
23%	50%	9%	9%	5%	5%	100%
14%	55%	5%	4%	5%	5%	100%
23%	27%	14%	23%	14%	5%	100%
27%	50%	5%	14%	0%	5%	100%
5%	36%	9%	36%	9%		100%
5%	18%	36%	32%	9%	0%	100%

3) Members of wine cooperatives have a competitive advantage in the market place. About 77 percent agreed and strongly agreed that farmers must stick together even if they have to give up some of their individual freedom. 45% rejected or disagreed that an individual farmer can make better marketing decisions than a group of farmers. The beliefs on the competitive advantage of the wine cooperative members in the market place have shown much ambivalence with 41 percent disagreed and strongly disagreed. 36 percent of the respondents were neutral showing mixed feelings about the dominance of the cooperative members in the market place. By implication the collective action practices in the wine cooperative is still well supported and perceived as a vehicle to access the market.

Concluding remarks

The cooperative principles are argued to be the lifeblood of the cooperative movement, derived from the values that have infused the movement from its beginnings. It is also believed that these principles shape the structures and determine the attitudes that provide the collective movement's distinct perspectives.

The cooperative movement is a movement of perpetual promise, a movement of becoming, not of ending. It never achieves a state of perfection nor it never rests satisfied with what it has accomplished. It is a movement that is always torn between what its philosophy suggests and the contemporary world requires. It is a movement that fails unless committed, pragmatic cooperators continuously consider the choices their cooperatives must make in responding to members' needs, in achieving proper goals, and in adhering to cooperative principles in their daily activities. They are choices that are never finally made. There are no decisions that are completely perfect.

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Die invloed van verpilling van diete op die produksie van slagvoëls

B.B.AUCAMP & T.S. BRAND

Inleiding
In oorsigte van navorsingsresultate oor die invloed van verpilde diëte op die produksie van enkelmaagdiere het resultate met varke (Vanschoubroek et al, 1971; Braude, 1972) sowel as pluimvee (Calet,1965) in die meerderheid studies getoon dat groeitempo verhoog en voeromset doeltreffender is met verpilde diëte in vergelyking met meel diëte. Enkelmaag diere het in die algemeen 'n voorkeur vir verpilde diëte waar 'n keuse gebied word. Minson (1963) het in 'n oorsig oor die invloed van verpilde diëte vir herkouers bevind dat verpilling groeitempo en inname verhoog het. Alhoewel verteerbaarheid van voere effens afneem as gevolg van die vinniger deurvloei deur spysverteringskanaal, lei hoër innames tot beter voeromset doeltreffendheid.

Inleiding

Minson (1963) en Calet (1965) skryf die verbetering in diereproduksie met die voer van verpilde diëte teenoor meel diëte hoofsaaklik toe aan verhoogde innames by onderskeidelik herkouers en pluimvee. Wainman et al (1972) is van mening dat met herkouers nie net verhoogde innames nie, maar ook chemiese verandering verbeterde produksie tot gevolg het. Vermindering in die vermorsing van voer met die voer van verpilde diete speel ook 'n baie groot rol in die verbetering in benutting van verpilde diete teenoor meel diete.

Teenstrydige resultate is verkry deur die hermaal van verpilde diëte vir pluimvee. Allred et al (1957) het bevind dat groei steeds verbeter is, maar Arscott et al (1957) het nie groei verskille tusen hergemaalde en onverpildediëte ondervind nie. Die voordeel in produksie wat met verpilde diëte met varke verkry word kan volgens Lawrence(1978) aan verminderde vermorsing, maar ook aan fisiese (vooraf maal en saampersing) en chemiese verandering van die diëet toegeskryf word. Daar is ook menings verskille of veranderinge wat diëte met verpilling ondergaan behoue bly met hermaal van verpilde diëte. Van die veranderinge wat ondervind word, is verminderde ruveselinhoud (Baird, 1973; Lawrence, 1971), verbeterde droëmateriaal en energie vertering (Gorrill et al,1960)en verhoogde aminosuur beskikbaarheid (Yen et al, 1971).

Minson (1963), Calet (1965) en Vanschoubroek et al (1971) maak almal melding van die verminderde vermorsing, minder stof, makliker hantering en beter vermening van grondstowwe wat met verpilde rantsoene verkry word.

Met enkelmaagdiere is bevind dat die verbeterde produksie as gevolg van verpilling afneem met 'n verhoging in die netto energie waarde van die diëte (Vanschoubroek et al, 1971). Greenhalgh en Wainman(1972) en Minson(1963) het met herkouers bevind dat die effek van verhoogde groeitempo en inname wat deur verpilling van diëte met hoë ruveselinhoud verkry word, verhoog namate die kwaliteit van die ruvoer verswak.

Die laer spysverteringskanaal van volstruise is baie langer as die van ander enkelmaag diere (Bezuidenhout en Van Aswegen,1990). Volstruise is daarom in staat om op laer kwaliteit voere met hoër veselinhoud (sellulose en hemisellulose) (Swart et al.,1993; Brand,2003) te oorleef. Die vermoë van volstruise om hoë veselinhoud diëte te benut en die moontlikheid dat verpilling die benutting van hoë ruvesel diëte kan verbeter, het dus 'n ondersoek na die invloed van verpilde diëte op volstruisproduksie geregverdig.

Metode

Eenhonderd agt-en-sestig slagvoëls is op die ouderdom van 20 weke ewekansig volgens liggaamsmassa in agt groepe van 21 elk met 'n gemiddelde liggaamsmassa van 42.2 kg ingedeel. Vier groepe elk het diëte met energiewaardes van onderskeidelik 10.0 en 11.5 MJ ME per kg voer tydens die groeifase ontvang (2 groepe as meel en 2 groepe verpil). (Sien Tabel 1). Vanaf 30 weke ouderdom het vier groepe elk diëte met energiewaardes van 8.8 en 10.0 MJ ME per kg voer onderskeidelik in die afrondingsfase ontvang (2 groepe as meel en 2 groepe verpil). (Sien Tabel 2). Liggaamsmassas is maandeliks geneem en voer inname per groep is bepaal. Groeitempo en voeromset per groep is bereken.

Tabel 1: Groeidiëte vir slagvolstruise met onderskeidelik 'n normale en lae energiewaarde

Bestandele (kg/ton)	Diëte	
	Normale energiewaarde	Laer energiewaarde
Lusern	414	677
Gars	440	200
Sojaboon oliekoek	96	66
Mellassestroop	25	25
Monokalsiumfosfaat	8.5	14
Voerkalk	6	10
Plantolie	2.5	0
Fynsout	4	4
Mineraal en Vitamien Premix	2.5	2.5
Sintetiese metionien	1.5	1.5
Berekende samestelling (natuurlike vogbasis)		

Tabel 2: Afronddiëte vir slagvolstruise met onderskeidelik 'n normale en lae energiewaarde

Bestandele (kg/ton)	Diëte	
	Normale energiewaarde	Lae energiewaarde
Lusern	718	938
Gars	209	0
Sojaboon oliekoek	30	10
Mellassestroop	25	25
Monokalsiumfosfaat	10.5	12.5
Voerkalk	0	7
Fynsout	4	4
Mineraal en Vitamien Premix	2.5	2.5
Sintetiese metionien	1.0	1.0
Berekende samestelling (natuurlike vogbasis)		

Resultate

Die produksie resultate van die volstruise word in Tabel 3 weergegee. Tydens die groeifase van die voëls is geen verskille as gevolg van die verpilling van die diëte of as gevolg van die energiewaarde van die diëte waargeneem nie. Tydens die afrondfase is beide die groeitempo van die voëls en die voeromset betekenisvol beinvloed. Voëls op verpilde diëte het 16% vinniger gegroei en 'n 24% beter voeromset gehad as voëls op die meel diëte. Voëls op diëte met 'n normale energiewaarde het terselfdertyd 25% vinniger gegroei en 'n 20% beter voeromset gehad as voëls op diete met 'n laer energiewaarde, soos verwag.

Tabel 3: Die invloed van verpilling op die produksie van slagvolstruise

Behandeling	PRODUKSIE PARAMETER		
	Inname, kg/ dag/voël	Groeitempo, g/d/voël	Voeromset, kg voer/kg massa toename
Groeifase: invloed van behandeling			
Pille	1.99 NBV	328 NBV	6.19 NBV
Meel	2.00 NBV	316 NBV	6.67 NBV
Invloed van energie			
Normale energie	1.95 NBV	325 NBV	6.25 NBV
Laer energie	2.04 NBV	319 NBV	6.61 NBV
Afrondingsfase: Invloed van behandeling			
Pille	2.82 NBV	192 a	14.0 a
Meel	3.02 NBV	166 b	18.5 b
Invloed van energie			
Normale energie	3.00 NBV	199 a	14.5 a
Laer energie	2.84 NBV	159 b	18.1 b

a, b Dui betekenisvolle ($p \leq 0.05$) verskille tussen behandelings aan.

Gevolgtrekking

'n Verbetering van 24% in voeromset weens verpilling is waargeneem tydens die afrondfase. Groeitempo van voëls op die verpilde diëte het ooreenkomstig met 16% verbeter. Die verpilling van volstruisdiëte is 'n praktyk wat redelik algemeen deur volstruisprodusente toegepas word. Alhoewel die verpilling van voere die koste van voere verhoog moet die hoër koste tenopsigte van infrastruktuur en arbeid ook opgeweeg word teen die beter vermenging van diëte, minder bergruimte wat benodig word, minder stof en makliker vervoer en hantering van verpilde diëte. Verpillingskoste word normaalweg bereken as 10% van die koste van grondstofkoste (Brand en Jordaan, 2004).

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