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Competition as a biotic ecological factor.

1- Ecological competition between Trifolium alexandrinum (Berseem) and Lolium multiflorum (rye) under different phosphorus levels

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ABSTRACT

Two field experiments were carried out during 1990/91 season, at special farm at Sharkeya province in silty loam and sandy loam soil, to study the effect of total stand % of berseem-rye associations and phosphorus fertilization on forage yields, botanical composition and nutritive value of the mixture.

The results indicated clearly that large yields were produced during the successive cuttings by the berseem associates grown in pure stand. But, however, the combined yields of berseem-rye associations grown with 115 and 130% total stands were statistically the same as that of the pure stand yield basis of berseem. On the average total dry yield bases of berseem and rye grown in pure stands, the relative increases due to those two treatments were 19 and 25%, in respective. However, for both the 1st and 2nd cuttings, berseem contributed 66 and 62% of the dry matter production produced by the mixture with a sharp decline in the 3rd cutting, while the associated rye grass supplied 51% in the 3rd cutting. In addition, compared to the pure stand yield of berseem, the results of the sandy loam soil indicate a 5.6 and 22.5% increases in T.D.N., and 4.0 and 9.2% for S.V. yields calculated for the total cuttings due to the berseem-rye association grown with 115 and 130% total stands, respectively.

The results of both silty loam and sandy loam soil revealed that increasing the total stand of the mixture from 100 up to 130% did not affect the competition index, competitive ratio (CR) and relative yield total% (RYT) calculated for forage yield . However, the results suggested that rye grass was the more competitive component, whereas the berseem could be considered the least, thus rye made benefit from the association with berseem. For the total stands of 100, 115 and 130%, yield advantages averaged 5, 23 and 28% for fresh yield, and 10, 20 and 26% for dry yield, in respective with an average mean of 18% advantage for each yield. Most of these advantages could be attributed to rye grass which had higher indices and ratios than berseem. In addition, the

RYT% on seed yield bases was 92, 107 and 124% for 100, 115 and 130% total stand, respectively with an average of 8% advantage.

Regarding phosphorus fertilization, for all cuts, any increase in P_2O_5 level was followed by a significant increase in fresh as well as dry forage, TDN and SV yields of berseem and rye associations. However, phosphorus affected the percent of berseem as well as rye in most of the cases. Over the two soil, the botanical composition on dry yield basis was 52, 60 and 64% for berseem, and 47, 39 and 36% for rye due to 0, 15.5 and 31.0 Kg P_2O_5 /fad. doses, respectively.

INTRODUCTION

Growing legumes and grasses in associations as a cultural practice may be a way to increase the biomass productivity as well as its quality. Many workers have noted this behaviour. Robert (1946) obtained beneficial responses to grasses from associated legumes. It is probable that legumes provided some N in addition to that applied as fertilizer ***(Macleod, 1965)***. In Egypt, ***Ibrahim (1975)*** found that berseem and Italian-rye grass mixture excelled pure berseem in forage yield, dry matter and feeding value. Also, ***Abou-Raya and Ibrahim (1975)*** showed that interseeding 14.4 and 4.8 Kg/ fad. berseem and rye had the highest feeding value (T.D.N. and S. V.) on dry matter basis. However, ***Beshay (1980)*** revealed that berseem /rye grass mixture exceeded the pure berseem. In addition,***Abd El-Gawad et al., (1984)*** reported that berseem-rye grass followed by berseem/oat and berseem/ barley mixtures were higher in dry yield and crude protein than their pure stands. On the other side, ***Habib & Badawy (1966)*** showed no advantage from berseem -- grass mixtures over pure berseem for forage yield or chemical composition. However, ***Doverat & Lachover (1958)*** reported that clover-grass mixture produce a well balanced feed regarding the nutrition value, while the mixture failed to produce much dry matter as pure clover.

Hussein et al., (1983) found that fresh and dry forages, S.V. and T.D.N. yields of berseem tended to increase with increasing P_2O_5 up to 45 Kg/fad., and up to 30 Kg for seed yield.

This paper reports forage yields, botanical composition and nutritive value of berseem and rye grass grown in pure stands and in association with and, without fertilizer phosphorus. The competitive parameters like

commutation index, competitive ratio (CR) and relative yield total (RYT) on forage .

Competition always occurs where two or more plants make demands for light, nutrients or water in excess of the supply. Hunt & ***Wagner (1963)*** stated that competition between the legume and its companion grass for nutrients, light and water is most important in legume persistence. Certain studies on the interrelationship between legume and grass mixtures have shown that the yield responses were compensating rather than mutually beneficial or antagonistic (Roberts & ***Olson, 1942)***. However, ***Kilcher et al.,(1966)*** in their study on the competition of grasses in mixtures with alfalfa found that excessive competition between grass species inflicted a two- way squeeze on the alfalfa associate. Their conclusion was that if two grasses are to be used in combination with alfalfa, it is very important that the competitive characteristics and degree of compatibility be understood before formulating the mixture. In Egypt, ***Radwan et al., (1977)*** indicated that the mixture yield was significantly affected by seeding rate of berseem and rye grass. They added that the highest yields were generally obtained from 20+ 8 Kg berseem / fad. rye, which did not show a significant advantage. However, ***Ibrahim et al., (1979)*** revealed that interseeding berseem and Italian rye grass (12+ 6 Kg seeds/ fad.) increased significantly dry matter output in comparison with pure berseem (24 Kg/ fad.). In addition, ***Gabra et al., (1984)*** noticed- in most of cases- that the mixture yield of berseem-barley association was nearly the same as high as the pure stand yield of berseem. Dry matter yields were somewhat higher in mixture than in pure stand of berseem.

Because of interspecific competition for nutrients in grass-legume mixtures ***(Blaser and Brady, 1950;*** and ***Mowat and Walker, 1959)***. special attention must be paid to fertilization practices if a favourable species balance is to be maintained. ***Macleod (1965)*** reported that there was competition between alfalfa and grass species for both N and K. He added that competition indices for alfalfa grown with orchard broom and timothy were 1.60, 1.30 and 1.60 respectively , without Nand 0.85, 0.07 and 1.30 with 200 pounds of N. Nitrogen increased the ability of the grass

species to compete with alfalfa for P. However, this investigation aimed to study the effect of mixture and phosphorus fertilization on competition of berseem-rye grass association.

MATERIALS AND METHODS

The present investigation was carried out at special farm in Sharkeya province during 1991/92 to study the effect of total mixture stand and phosphorus fertilization of berseem-rye grass mixture on forage yield. The Meskawy variety of Egyptian clover (Trifolium alexandrenum L.) and Italian ryc grass (Lolium multiflorum L.) were used.

The experiment included 15 treatments which were the combinations of a) five planting patterns and h) three levels of phosphorus fertilization i.e. 0, 15.5 and 31.0 Kg P_2O_5 /fad. Planting patterns used were as follows:

1. Pure stand of berseem (20 Kg seeding rate/ fad.).
2. Pure stand of rye grass (12 Kg seeding rate/ fad.).
3. Berseem-rye grass mixture, using 50% + 50% of the corresponding seeding rates. This provides 100% total stand/fad.
4. Berseem- rye grass mixture, using 57.5% + 57.% of the corresponding seeding rates. This provides 115% total stand/fad.
5. Berseem- rye grass mixture, using 65%+ 65% of the corresponding seeding rates. This provides 130% total stand/fad.

The treatments were arranged in a split- plot design with three replicates. The planting patterns used were assigned to the main plots, and suh- plots were devoted to the levels of phosphorus fertilization. Plot area was 10.5 m x 3.5 m). Before sowing, calcium super- phosphate fertilizer (15.5 P_2O_5) was added with the chosen levels. Seeds were broadcasted in silty loam and sandy loam soil, respectively. Nitrogen fertilizer (urea 46% N) was added three times with the rate of 8.0 Kg N/fad. for each, the first part was applied at sowing, while the 2nd and 3rd parts were added after the 1st and 2nd cuts. Three cuts were taken at 35, 44 and 68 day ages in silty loam soil and 22,42 and 64 day ages in sandy loam soil .

Dry forage yield was determined for every cut for berseem as well as rye grass in pure stand and mixture. After the third cut, plants were left to produce their seeds and seed yield was recorded.

In addition, botanical composition for berseem and rye associations on dry forage yield basis was calculated for each cutting as well as the total cuts of each associate. However, the feeding value as total digestive nutrients (TDN) and starch value % was calculated for the total harvest of green berseem by a knowledge of dry matter % (DM) of the green berseem as follows:

TDN % = 0. 625 DM% - 0.15
SV% = 0. 432 DM% + 1.20

Data obtained were subjected to the standard statistical methods of variance following Fisher technique.

For both fresh and dry forage yields/ fad., the following competition parameters were calculated:

1. Competition index (relative yield RY):

The ratio of a given criteria for a species grown in a mixture compared to that in pure stand was termed the " competition index" of each species. That index was determined for fresh as well as dry forage yield/fad. according to ***Macleod (1965)*** as follows.

Competition index= Yield in mixture/ Yield in pure stand

2. Competitive ratio (CR):

The competitive ratio was calculated for dry forage yield using the following procedures suggested by ***Willey and Rao (1980):***

$$CR = [(I_a / M_a)(I_b / M_b)^{-1}](S_b / S_a)$$

where:

I_a= mixture yield of crop $_a$.
I_b= mixture yield of crop $_b$.

M_a= pure stand yield of crop $_a$
M_b= pure stand yield of crop $_b$
S_a= sown proportion of crop $_a$
S_b= sown proportion of crop $_b$

3. Relative yield total % (RYT):

The relative yield total % (RYT) of a mixture is the sum of the RY's of the mixture components.

In addition, the relative yield %, competitive ratio and relative yield total % were calculated for seed yield/fad.

Data obtained were subjected to the standard statistical methods of variance following Fisher's technique.

RESULTS AND DISCUSSION

Data in Table (1) indicate that large yields were produced by planting the berseem associates in pure stand. This could be seen during the three cuts as well as their totals in silty loam and sandy loam soil . But, however, the combined mixture yield of berseem-rye associations grown in 115 and 130% total stands were statistically the same as that of the pure stand yield of berseem. This was the case in botb the 1st and 2nd cuts in silty loam soil. In other words, the total fresh forage yield (Ton/fad.) of berseem grown alone was comparable to the combined mixture yield of berseem -rye associations grown in 115 or 130% total stands, this was true in both silty loam and sandy loam soil. These results are in agreement with those reported by Habib and Badawy (1966). The results obtained herein also indicated that fresh forage yield of the pure stand of rye associate was significantly the least. This was true for the total fresh forage yields of all the three cuts as well as their totals in both soil . However, the highest fresh forage yield can be accounted for in the 2nd harvest, where the mixture yield of herseem contributed 65% and that of rye 35% in the combined respective yield. It is worthy to note that the average total fresh yield of both berseem and rye grown in pure stands was 10. 26 and 7.63 (Ton/fad.) in silty loam and sandy loam soil, the

respective combined mixture yields averaged 11.05 and 8.92 in both soil, respectively.

With respect to phosphorus fertilization, it was found that any increase in P_2O_5 level was followed by a significant increase in the fresh forage yield (Ton/fad). This was- in general- true during the three cuts and their totals for berseem as well as rye and their mixture yield in the two types of soil . Where, in the two soil, the relative increase in the total fresh forage yield of berseem-rye mixture reached 43% and 94% due to adding 15.5 and 31.0 Kg P_2O_5/fad., respectively. Similar results were also recorded by ***Hussein et al., (1983).***

The results of dry forage yield (Table, 2) concerning the effect of planting pattern and phosphorus fertilization are similar with that of fresh forage yield (Table, 1). However it was found that, on the average total dry yield basis of the two component crops grown in pure stand, the relative increases in the total dry yields which could be achieved by planting 115 and 130% total stands of the berseem-rye associations averaged 19 and 25%, respectively.

The percentage of herseem as well as rye grass in the berseem-rye associations on a dry matter basis for each cutting for each soil is shown in Table (3). It is clear that increasing the total stand% of the mixture from 100 up to 130% did not affect the botanical composition for berseem as well as rye grass based on dry yields. This was true for the three cuts and their totals in both soil. However, over the two seasons, the percentage of berseem in the berseem-rye associations on dry matter basis tended to decrease with successive cuts, whereas the botanical composition for rye grass was increased. It is also recognized that in the 1st and 2nd cuttings, berseem contributed 66 and 62% of the dry matter production produced by the mixture with a sharp decline in the 3 rd cutting. However, rye grass grown in association with berssem supplied 51% of the production in the 3 rd cutting.

Regarding phosphorus fertilization, it is obvious that phosphorus treatments affected tbe percent of berseem as well as rye in most of the cases as shown in both soil. Thus, a heavy rate of P fertilization appeared

to accelerate rather than prevent the reduction in percent berseem in the mixture. The opposite was true in rye case. However, the peak value was achieved in the 1st cut for berseem and in the 3 rd one for rye. For both soil, the botanical composition on dry yield basis was 52, 60 and 64% for berseem, and 47, 39 and 36% for rye for 0, 15.5 and 31.0 kg P_2O_5/fad levels.

The results presented in Table (4) show that large seed yield could be achieved due to growing each component crop of the mixture in pure stand. Where the treatments of 100, 115 and 130% total mixture stands on one hand had lower seed yield/fad. of the associated rye grass compared to the pure stand yield on the other hand. This was - in general - true for berseem association. Concerning P fertilization, seed yield (Kg/fad.) of berseem as well as the associated rye grass was gradually increased due to any increase in P level, this was clear in silty loam soil. However for the sandy loam soil , the unfertilized plants had lower seed yield compared to the heavy dose of P, this was - in general true for berseem and rye associations.

Generally for both total digestive nutrients (T. D. N.) and starch value (S. V.) it is of interest to note from Table (5) that the berseem TDN as well as S.V. was nearly as that of the berseem - rye yields, but rye alone. gave the lowest value. However. the results of sandy loam soil indicate a 5,6 and 22.5% increases in T.D.N, and 4.0 and 9.2% for S. V. due to growing berseem and rye in associations with the total stands of 115 and 130% when comparing with the respective berseem pure stand values, respectively. These results are similar with those recorded by ***Abou-Raya and Ibrahim (1975).*** With respect to P fertilization, a gradual increase in T. D. N. as well as S. V. values could be observed due to increasing P level from 0 to 15.5 and 31.0 Kg P_2O_5/ fad. These results confirmed those obtained by ***Hussein et al. (1983).***

Competition index in berseem rye associations on fresh and dry forage yield/ fad. basis for each cutting as influenced by mixture and phosphorus fertilization is presented in Tables (6) .It is evident from these data that the competition index for both berseem and rye associations based on fresh as well as dry yield are lower unity, this was true in both soil. This indicated that there was competition between berseem and rye

for recourses used. These results are in agreement with those reported by ***Macleod (1965).*** Competition always occurs where two or more plants make demands for light, nutrients, or water in excess of the supply. Competition then is essentially a decrease in the amount of these resources available for each individual ***(Dubbs,1971).*** However, for both soil, increasing the percentage of the total mixture stand from 100 up the 130% did not affect the competition index on fresh as well as dry yield basis for each component crop. Over the two soil, the competition index on dry yield basis for berseem reached a maximum in the 2 nd cut. This indicated that most of the contribution of berseem in total dry matter of the mixture yield can be accounted for in the 2nd cut. However, the competition index for the total forage yield of berseem and rye associations averaged 0.47 and 0.70 for fresh yield, and 0.51 and 0.67 for dry yield, respectively. These results suggest that rye grass was the most competitive crop. whereas the berseem could be considered the least. In this respect, ***Garter and Scholl (1962)*** reported that forage grasses may be supplied with supplemental nitrogen from N fixed by root bacterial nodule growing symbiotically with associated legumes.

With respect to phosphorus fertilization, although, the differences in the competition index for each component crop of the mixture based on fresh as well as dry yield were not significant, these indices tended to increase with increasing the level of phosphorus.

It is evident from Table (7) that varying the total stand percentage of the berseem-rye association from 100 up to 130 % did not affect the competitive ratio for each associate calculated for the dry yield. However, the competitive ratio for berseem (CR_b) was less than one, while it exceeded unity for rye grass. These results are similar with that of the competition index (Table 7) being the competition always infavour of the rye component. CR_b decreased with successive cuts, while the ratio for rye (CR_r) increased. Over the two soil, CR_r 0.62 0,80 and 0.86 and the corresponding CR_r was 0.59, 1.29. 1.21 and 1.21 for 100 ,115 and 130% total mixture stand, respectively. Here it should be stressed that a competitive ratio in excess of 1 signifies that rye grass grew better when

associated with berseem than when grown alone. Thus rye - grass was benefited by its association with berseem.

It is obvious that competitive ratios for berseem and rye associations based on dry forage yield were not significantly changed due to adding phosphorus up to 31.0 Kg P_2O_5/fad. dose. This was true for all cuts except CR_r for the 3 rd cut in sandy loam soil . where it was significantly higher at the highest level of 31.0 Kg P_2O_5/ fad. compared to that obtained from the control. However, phosphorus fertilization tended to increase CR_b, while CR_r was decreased. Over both soil. for unfertilized plants and those fertilized with 15.5 and 31.0 Kg P_2O_5/ fad.,CR_b was 0.72, 87 and 0.79, and CR_r was 1.42. 1.32 and 1.29, in respective.

Relative yield total (RYT) on fresh and dry forage yields basis for berseem - rye mixture for each cutting as influenced by mixture and phosphorus fertilization is shown in Tables (8 and 8-a), respectively. It is evident from these tables that berseem - rye associations produced a RYT of more than 100%. However, the most forage yield advantages can be accounted for in sandy loam soil which ammounted 26% for fresh yield and 22% for the dry yield. It is also found that both 115 and 130% total stands of the mixture on one hand bad higher yield advantage compared to 100% total stand. This was true, for the 1 st cut of the fresh as well as dry yield in sandy loam soil. Similar trend was observed for the total cuts of fresh yield in sandy loam soil. over the two soil and for the treatments of 100. 115 and 130% total stand of the mixture, the advantages valued 5, 23 and 28% for fresh yield, and 10, 20 and 26% for dry yield, in respective with an average mean of 18% advantage for fresh as well as dry forage yield. Most of these advantages could be attributed to rye grass component which had a high competition index (Tables 6 and 6-a) and competitive ratio (Table 6). One of the advantages of mixtures is that higher total yields are frequently obtained from mixture stands than from pure stands. Certain studies on the interrelationship between pure stands and grass mixtures have shown that the yield responses were compensating rather than mutually beneficial or antagonistic *(Roberts and Olson, 1942).*

Concerning phosphorus fertilization, it is clear that the RYT based on fresh as well as dry yield for the 2nd cut was significantly increased

with increasing phosphorus level up to 31.0 Kg P_2O_5/fad. in silty loam soil and 15.5kg in sandy loam soil. However, adding phosphorus caused a significant increase in RYT calculated for the total fresh yield. For the two soil, the RYT valued 107, 121 and 128% for fresh yield, and 110, 120 and 126% for dry yield of the mixture for the levels of 0, 15, 5 and 31,0kg P_2O_5/ fad., respectively.

The results presented in Table (9) reveal that the relative yield% (RYT) i.e. the competition index and the competitive ratio (CR) for berseem seed yield were significantly increased with increasing the percentage of the total mixture stand from 100 or 115 to 130%. over the two soils, the RY% and CR based on seed yield for herseem were higher than those obtained for the rye association. However, for both soils, the RYT% on seed yield basis averaged 92, 107 and 124% for 124% for 100, 115 and 130% total stand, respectively with an average mean of 8% advantage. with respect to phosphorus. It is of indorsed to note that both 15.5 and 31.0 kg P_2O_5 rates on one hand had higher CR_b compared to the control, on the other hand, the opposite was clear for CR. This was true in the silty loam soil. However, the results of both soils indicated that applying 15.5 and 31.0 kg P_2O_5/ fad resulted in a yield advantage of 10 and 15% for seed yield, respectively.

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Table (1): Fresh forage yield (ton/fad.) for berseem, rye and total for each cutting as influenced by planting pattern and phosphorus fertilization. (1991/1992 season).

Main effects	Barseem				Mixture component plants Rye				Total			
	1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total
Planting pattern:	Silty loam soil											
Berseem% Rye% Total %												
100 0 100	0.423	2.245	0.895 b	3.56 b	-	-	-	-	0.423c	2.245c	0.895c	3.56c
0 100 100	-	-	-	-	0.099	0.677	0.446b	1.22	0.099a	0.677a	0.446a	1.22a
50 50 100	0.151	0.948	0.367 a	1.41 a	0.035	0.400	0.355a	0.79	0.187a	1.348ab	0.722b	2.25b
57.5 57.5 115	0.155	1.480	0.369 a	2.00 a	0.039	0.433	0.365a	0.83	0.195a	1.914bc	0.734b	2.84bc
65 65 130	0.212	1.450	0.382 a	2.04 a	0.060	0.523	0.334a	0.90	0.263b	1.973bc	0.717b	2.98bc
F. test	N.S.	N.S.	**	*	N.S.	N.S.	*	N.S.	*	*	**	*
Phos. fer. (kg P_2O_5/fad.):												
0	0.128 a	1.008 a	0.373 a	1.50 a	0.041 a	0.379a	0.324a	0.74a	0.134a	1.110a	0.558a	1.82a
15.5	0.210 b	1.446 b	0.515 ab	2.13 b	0.054 b	0.482a	0.378a	0.91b	0.212b	1.545b	0.715b	2.47b
31.0	0.370 c	2.135 c	0.621 b	3.12 c	0.072 c	0.663b	0.423c	1.16c	0.354c	2.239c	0.836c	3.43c
F. test	**	**	*	**	**	**	**	**	**	**	**	**
Planting pattern:	Sandy loam soil											
Berseem% Rye% Total %												
100 0 100	0.249b	1.248	0.534c	2.03b	-	-	-	-	0.249b	1.248	0.534a	2.03b
0 100 100	-	-	-	-	0.152c	0.772b	0.547b	1.47b	0.152a	0.772	0.547a	1.47a
50 50 100	0.092a	0.591	0.284a	0.96a	0.050a	0.569a	0.354a	0.96a	0.142a	1.160	0.639b	1.93ab
57.5 57.5 115	0.094a	0.740	0.305ab	1.14a	0.131b	0.486a	0.369a	0.98a	0.225b	1.226	0.674b	2.13b
65 65 130	0.114a	0.821	0.328b	1.26a	0.098b	0.520a	0.342a	0.96a	0.212b	1.348	0.670b	2.29b
F. test	*	N.S.	**	*	*	*	*	**	*	N.S.	**	*
Phos. fer. (kg P_2O_5/fad.):												
0	0.090a	0.365a	0.243a	0.69a	0.077a	0.456a	0.345a	0.87a	0.134a	0.657a	0.434a	1.22a
15.5	0.146b	0.875b	0.363b	1.38b	0.102a	0.596b	0.382a	1.08b	0.199b	1.177b	0.555a	1.93b
31.0	0.176c	1.811c	0.483c	1.97c	0.143b	0.705c	0.481a	1.33c	0.256c	1.612c	0.734c	2.90c
F. test	**	**	**	**	**	**	**	**	**	**	**	**

Table (2): Dry forage yield (ton/fad.) for berseem, rye and total for each cutting as influenced by planting pattern and phosphorus fertilization, (1991/1992 season).

Main effects	Berseem				Mixture component plants Rye				Total			
	1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total
Planting pattern:	**Silty loam soil**											
Berseem% Rye% Total %												
100 0 100	3.02	9.33 b	3.14 b	15.49 b	-	-	-	-	3.02 c	9.33 c	3.14 c	15.49 c
0 100 100	-	-	-	-	1.00	2.64	1.48 b	5.04	1.00 a	2.64 a	1.48 a	5.04 a
50 50 100	1.22	3.62 a	1.28 a	6.33 a	0.49	1.64	1.18 a	3.31	1.72 ab	5.25 ab	2.47 b	9.44 b
57.5 57.5 115	1.81	5.47 a	1.25 a	8.03 a	0.61	1.84	1.17 a	3.63	1.92 ab	7.31 bc	2.42 b	11.65 bc
65 65 130	1.56	5.40 a	1.25 a	8.025 a	0.69	1.99	1.11 a	3.80	2.29 bc	7.40 bc	2.36 b	12.06 bc
F. test	N.S.	*	**	*	N.S.	N.S.	*	N.S.	*	*	**	*
Phos. fer. (kg P_2O_5 /fad.):												
0	1.07 a	4.08 a	1.28 a	6.44 a	0.55 a	1.49 a	1.07 a	3.12 a	1.30 a	4.46 a	1.68 a	7.65 a
15.5	1.64 a	5.67 b	1.75 a	9.07 b	0.71 b	1.91 a	1.25 b	3.88 b	1.89 b	6.07 b	2.40 b	10.36 b
31.0	2.64 b	8.12 c	2.56 b	12.91 c	0.83 c	2.59 b	1.40 c	4.03 c	2.77 c	8.57 c	2.46 c	14.20 c
F. test	**	**	*	**	**	**	**	**	**	**	**	**
Planting pattern:	**Sandy loam soil**											
Berseem% Rye% Total %												
100 0 100	2.48 b	4.90	1.80 c	9.55 b	-	-	-	-	2.84 c	4.90	1.80	9.55 b
0 100 100	-	-	-	-	1.16 c	2.78 b	1.76	5.71 c	1.16 a	2.78	1.76	5.71 a
50 50 100	0.87 a	2.40	0.95 a	4.23 a	0.58 a	2.71 b	1.18	3.84 a	1.45 ab	4.47	2.13	8.07 ab
57.5 57.5 115	0.86 a	2.89	1.06 b	4.81 a	1.06 b	1.99 a	1.23	4.28 b	1.92 b	4.88	2.28	9.09 b
65 65 130	1.18 a	3.25	1.06 b	5.45 a	0.90 b	2.14 a	1.10	4.16 b	2.03 b	5.40	2.16	9.61 b
F. test	**	N.S.	**	*	**	**	N.S.	**	**	N.S.	N.S.	*
Phos. fer. (kg P_2O_5 /fad.):												
0	0.99 a	1.46 a	0.80 a	3.27 a	0.66 a	1.79 a	1.13 a	3.59 a	1.33 a	2.61 a	1.55 a	5.49 a
15.5	1.52 b	3.45 b	1.20 b	6.18 b	0.85 a	2.26 b	1.25 a	4.37 b	1.90 b	4.57 b	1.97 b	8.44 b
31.0	1.76 c	3.17 c	1.63 c	8.57 c	1.26 b	2.68 c	1.58 b	5.52 c	2.42 c	6.28 c	2.57 c	11.28 c
F. test	**	**	**	**	**	**	**	**	**	**	**	**

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Table (3): Botanical composition for berseem, rye mixture on dry matter basis for each cutting as affected by mixture and phosphorus fertilization, (1991/1992 season).

Main effects			Berseem				Mixture component plants Rye			
			1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total
Planting pattern:			Silty loam soil							
Berseem%	Rye%	Total %								
50	50	100	0.81	0.67	0.05	0.60	0.19	0.33	0.50	0.37
57.5	57.5	115	0.75	0.77	0.05	0.70	0.25	0.23	0.50	0.30
65	65	130	0.78	0.72	0.52	0.67	0.22	0.28	0.48	0.32
F. test			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Phos. fer. (kg P_2O_5 /fad.):										
0			0.73a	0.67	0.47	0.61a	0.27b	0.33	0.53	0.38b
15.5			0.80b	0.73	0.52	0.65a	0.25a	0.27	0.48	0.33ab
31.0			0.82b	0.76	0.53	0.71b	0.18a	0.24	0.47	0.29a
F. test			*	N.S.	N.S.	**	*	N.S.	N.S.	*
Planting pattern:			Sandy loam soil							
Berseem%	Rye%	Total %								
50	50	100	0.66	0.45	0.44	0.48	0.34	0.53	0.56	0.52
57.5	57.5	115	0.41	0.57	0.45	0.51	0.59	0.43	0.55	0.48
65	65	130	0.55	0.59	0.48	0.55	0.45	0.41	0.52	0.45
F. test			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Phos. fer. (kg P_2O_5 /fad.):										
0			0.54	0.42a	0.41a	0.42a	0.46	0.58b	0.59b	0.57b
15.5			0.55	0.56b	0.48b	0.55b	0.45	0.42a	0.52a	0.45a
31.0			0.53	0.62b	0.45b	0.57b	0.47	0.38a	0.52a	0.43a
F. test			N.S.	**	*	**	N.S.	**	**	*

Table (4): Seed yield (kg/fad.) of berseem and rye as influenced by mixture and phosphorus fertilization (1991/1992 season).

Main effects			Silty loam soil		Sandy loam soil	
			Barseem	Rye	Barseem	Rye
Planting pattern:						
Berseem%	Rye%	Total %				
100	0	100	346.76 c	-	202.15b	-
0	100	100	-	58.16b	-	63.60b
50	50	100	161.13a	32.95a	99.18a	27.50a
57.5	57.5	115	156.06a	83.41a	155.80ab	25.31a
65	65	130	247.76b	32.63a	151.43ab	32.08a
F. test			**	*	*	*
Phos. fer. (kg P_2O_5 /fad.):						
0			145.82a	28.68a	91.73a	25.00a
15.5			227.01b	35.81b	169.95b	88.78ab
31.0			301.96c	53.37c	194.66b	49.77b
F. test			**	**	**	*

Table (5): Total digestive nuterients (T.D.N.) and starch value (S.V.) (Ton/fad.) for the total cuts as affected by mixture and phosphorus fertilization (1991/1992 season).

Main effects			T.D.N.		S.V.	
			Silty loam soil	Sandy loam soil	Silty loam soil	Sandy loam soil
Planting pattern:						
Berseem%	Rye%	Total %				
100	0	100	2.19c	1.24ab	1.71b	0.98b
0	100	100	0.75a	0.78a	0.58a	0.61a
50	50	100	1.38b	1.18ab	1.08ab	0.92b
57.5	57.5	115	2.22c	1.31b	1.36ab	1.02b
65	65	130	1.83bc	1.52b	1.42ab	1.07b
F. test			**	**	**	*
Phos. fer. (kg P_2O_5 /fad.):						
0			1.12a	0.75	0.87a	0.59a
15.5			1.52b	1.28	1.18b	0.92b
31.0			2.39c	1.60	1.64c	1.25c
F. test			**	N.S.	**	**

Table (6): Competition index for berseem-rye mixture on fresh yield basis for each cutting as affected by mixture and phosphorus fertilization.

Main effects			1 st cut		2 nd cut		3 rd cut		Total	
			Berseem	Rye	Berseem	Rye	Berseem	Rye	Berseem	Rye
Mixture:			Silty loam soil							
Berseem %	Rye %	Total%								
50	50	100	0.43	0.49	0.35	0.63	0.40	0.79	0.37	0.65
57.5	57.5	115	0.44	0.61	0.57	0.75	0.41	0.78	0.50	0.72
65	65	130	0.53	0.71	0.57	0.81	0.39	0.74	0.52	0.76
	F. test		N.S.	N.S.	N. S.	N. S	N. S.	N. S.	N. S	N. S.
Phos. fer. (kg P_2O_5 /fad.):										
0			0.49	0.51a	0.38	0.68	0.41	0.73	0.40	0.66
15.5			0.48	0.62b	0.50	0.74	0.41	0.82	0.48	0.73
31.0			0.43	0.67b	0.61	0.77	0.38	0.76	0.52	0.73
F. test			N. S.	*	N. S.	N. S	N. S.	N. S.	N. S.	N. S.
Mixture:			Sandy loam soil							
Berseem %	Rye %	Total%								
50	50	100	0.31	0.48	0.46	0.74 b	0.55	0.68	0.42	0.66
57.5	57.5	115	0.30	0.97	0.58	0.70 a	0.61	0.69	0.49	0.74
65	65	130	0.37	0.80	0.67	0.75 b	0.61	0.62	0.56	0.71
	F. test		N. S.	N. S.	N. S.	*	N. S.	N. S.	N. S.	N. S.
Phos. fer. (kg P_2O_5 /fad.):										
0			0.29	0.77	0.46 a	0.62 a	0.64	0.63	0.45 a	0.64
15.5			0.33	0.67	0.64 b	0.74 ab	0.61	0.65	0.51 b	0.69
31.0			0.35	0.81	0.59 b	0.83 b	0.53	0.68	0.52	0.76
F. test			N. S.	N. S.	*	*	N. S.	N. S.	*	N. S.

Table (6-a): Competition index for berseem-rye mixture on dry matter basis for each cutting as influenced by mixture and phosphorus fertilization.

Main effects	1 st cut		2 nd cut		3 rd cut		Total	
	Berseem	Rye	Berseem	Rye	Berseem	Rye	Berseem	Rye
Mixture:			Silty loam soil					
Berseem % Rye % Total%								
50 50 100	0.38	0.37	0.38	0.58	0.40	0.79	0.36	0.64
57.5 57.5 115	0.39	0.41	0.64	0.66	0.42	0.81	0.55	0.69
65 65 130	0.52	0.53	0.64	0.79	0.42	0.74	0.56	0.74
F. test	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
Phos. fer. (kg P_2O_5 /fad.):								
0	0.39	0.45	0.43	0.64	0.41	0.76	0.42	0.66
15.5	0.46	0.42	0.57	0.68	0.42	0.83	0.50	0.71
31.0	0.44	0.44	0.66	0.71	0.40	0.76	0.55	0.69
F. test	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
Mixture:			Sandy loam soil					
Berseem % Rye % Total%								
50 50 100	0.36	0.31 a	0.44	0.72	0.55	0.64	0.46	0.65
57.5 57.5 115	0.34	0.90 b	0.58	0.62	0.59	0.68	0.54	0.66
65 65 130	0.45	0.68 b	0.66	0.66	0.63	0.62	0.62	0.64
F. test	N. S.	*	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
Phos. fer. (kg P_2O_5 /fad.):								
0	0.40	0.62	0.47 a	0.60	0.63	0.62	0.51	0.60
15.5	0.35	0.61	0.63 b	0.65	0.60	0.64	0.55	0.64
31.0	0.41	0.66	0.58 ab	0.74	0.54	0.66	0.56	0.70
F. test	N. S.	N. S.	*	N. S.	N. S.	N. S.	N. S.	N. S.

Table (7): Competitive ratio (CR) for berseem (CR_b) and rye (CR_r) grown in mixture on dry matter basis as influenced by mixture and phosphorus fertilization.

Main effects			Berseem				Mixture component plants Rye			
			1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total
Planting pattern:			Silty loam soil							
Berseem%	Rye%	Total %								
50	50	100	1.16	0.63	0.60	0.56	1.08	1.67	1.94	1.80
57.5	57.6	115	0.94	0.99	0.61	0.79	1.36	1.03	1.99	1.23
65	65	130	1.18	0.84	0.55	0.77	1.38	1.43	1.71	1.40
F. test			N. S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Phos. fer. (kg P_2O_5 /fad.):										
0			1.04	0.65	0.54	0.61	1.30	1.65	1.79	1.64
15.5			1.20	0.84	0.60	0.71	0.99	1.32	1.99	1.50
31.0			1.05	0.98	0.52	0.80	1.44	1.16	1.86	1.29
F. test			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Planting pattern:			Sandy loam soil							
Berseem%	Rye%	Total %								
50	50	100	1.24	0.60	0.84	0.69	0.86	1.63	1.11	1.38
57.5	57.5	115	0.37	0.96	0.88	0.81	2.56	1.11	1.12	1.19
65	65	130	0.83	1.01	1.00	0.96	1.52	0.99	0.97	1.02
F. test			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Phos. fer. (kg P_2O_5 /fad.):										
0			0.95	0.82	0.99	0.84	1.59	1.35	0.86 a	1.21
15.5			0.77	0.97	0.93	0.85	1.89	1.09	1.12 ab	1.14
31.0			0.69	0.79	0.79	0.78	1.46	1.30	1.22 b	1.25
F. test			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.

Table (8): Relative yield total % (RYT) of berseem-rye associations on fresh forage yield basis for each cutting as influenced by mixture and phosphorus fertilization.

Main effects			Silty loam soil				Sandy loam soil			
			1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total
Planting pattern:										
Berseem%	Rye%	Total %								
50	50	100	92	99	120	102	70 a	119	122	109 a
57.5	57.5	115	105	132	119	123	127 b	128	130	128 b
65	65	130	124	139	114	128	117 b	142	124	128 b
F. test			N. S.	N. S.	N. S.	N. S.	*	N. S.	N. S.	*
Phos. fer. (kg P_2O_5 /fad.):										
0			101	107 a	115	106 a	108	109 a	128	109 a
15.5			110	124 ab	124	121 b	105	138 b	126	121 ab
31.0			111	139 b	114	126 b	117	142 b	122	130 b
F. test			N. S.	*	N. S.	*	N. S.	*	N. S.	*

Table (8-a): Relative yield total % (RYT) of berseem-rye associations on dry matter basis for each cutting as influenced by mixture and phosphorus fertilization.

Main effects			Silty loam soil				Sandy loam soil			
			1 st cut	2 nd cut	3 rd cut	Total	1 st cut	2 nd cut	3 rd cut	Total
Planting pattern:										
Berseem%	Rye%	Total %								
50	50	100	75	96	119	100	67 a	116	119	111
57.5	57.5	115	81	131	123	124	124 b	120	125	121
65	65	130	106	143	116	130	113 b	132	125	126
F. test			N. S.	N. S.	N. S.	N. S.	*	N. S.	N. S.	N. S.
Phos. fer. (kg P_2O_5 /fad.):										
0			85	107 a	116	108	102	108 a	125	112
15.5			89	125 ab	125	122	96	129 b	124	119
31.0			88	138 b	117	125	107	133 b	121	127
F. test			N. S.	*	N. S.	N. S.	N. S.	*	N. S.	N. S.

Table (9): **Relative yield % (RY), competitive ratio (CR) and relative yield total % (RYT) of berseem-rye associations on seed yield basis as affected by mixture and phosphorus fertilization.**

Main effects	Silty loam soil					Sandy loam soil				
	Berseem		Rye		RYP%	Berseem		Rye		RYP %
	RY%	CR	RY%	CR		RY%	CR	RY%	CR	
Planting pattern:										
Berseem% Rye% Total %										
50 50 100	38 a	0.72 a	56	2.16	94	47	1.16	44	1.31	91
57.5 57.5 115	43 a	0.72 a	57	1.50	100	75	1.93	39	0.52	114
65 65 130	71 b	1.28 b	54	0.80	126	74	1.58	49	0.66	123
F. test	*	*	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.
Phos. fer. (kg P_2O_5 /fad.):										
0	34	0.65 a	55	2.38 b	89	66	1.65	40	0.68	106
15.5	57	1.01 b	55	1.10 a	112	64	1.53	45	0.99	109
31.0	61	1.06 b	57	0.99 a	118	66	1.49	46	0.89	113
F. test	N. S.	*	N. S.	**	N. S.	N. S.	N. S.	N. S.	N. S.	N. S.