RESEARCH ARTICLE Agricultural Science Digest, Volume 41 Issue 4: 610-614 (December 2021)

The Effect of Cereal-legume Intercropping Systems on the Cereal Grain Yield under Semi-arid Conditions

C. Benider, S. Laour, T. Madani, A. Gundouz, H. Kelaleche

10.18805/ag.D-346

ABSTRACT

Background: The aim of this study is to ascertain the response of dual exploitation of intercrops systems their ability to produce forage and grain. Thus the efficiency of the cereal-legume intercropping on the qualitative and quantitative improvement yield of cereals.

Methods: The experiment was conducted at the Setif University Experimental Farm during the years of 2019-20. The experiment was laid out in completely randomize block (CRB) design with three replications. Three cereals namely triticale, oats and barley in association with forage pea and other mixtures with (*Vesce commune*) were studied. The measure focused on accumulation of dry matter accumulation (DMA), plant height, flag leaf length (FLL), grain yield (GY) and thousand kernels weight (TKW).

Result: The results indicate that capacity of intercropping system systems to produce more dry matter than their mono cropping systems, as well as the intercropping systems significantly improved the qualitative and quantitative yield of cereals in all the tested intercropping systems. A positive significant correlation between SH and FLL r = 0.78 in the peas/oats intercrop. Thus use like this positive significant correlation between DMP GYr = 0.94, while the tritical / pea and barley / pea intercropping are characterized by the best DMP, GY and TKW among different tested cropping systems.

Key words: Cereal, Forage, Intercropping, Legume, Yield.

INTRODUCTION

The main role of fallow is to store as much water as possible in the soil. It is also used for forage production in the what is the fall here season like *kharif* winter and early spring. Unfolded fallow is an uncultivated field where weeds grow, its essential role is the production of fodder, but this fodder is generally poor add quality, due to overgrazing which favors the resistance of but this fodder is generally poor add quality, due to overgrazing which favors the resistance of uncontaminated species and the lack of fertilizers. Pattison (1979) reports that this is the well known practice in northern Africa cereals and animals are add by this practice. Legumes can play a significant role in absorption of large fallow agricultural areas through their use in rotation and/or in association with cereals (Drevon and ounane, 2009). In this context, developed policies should consider fallow as a component of cereal/sheep production systems because it constitutes a tool for combating climate hazard and for managing economic risk (Abbas and Abdelguerfi, 2005). Yield is a dependent character. It depends on various characters and environmental conditions that exist during crop growth (Borah *et al*., 2020). The protein content in cereal grains depends upon the genotype and environmental factors (Abdelaal *et al*., 2019). Some leguminous cover crops hold potential for possible use in the sustainable production, this could also help the farmer to reduce cost of production (Boateng and Tetteh, 2020). Among the cultivable rotation on the combined cereal-legume crops in fallow, intercropping which ensures a higher productivity in terms of total biomass produced by the intercropping system The intercropping system of grass and fodder legume gave higher productivity than grown as sole crops (Jensen, 1996 and Meena *et al*., 2011). The adoption of intercropping crops lies in the gain in overall performance over pure (monocroping) crops and in the significant and quasi-static improvement in the protein content of the grain, regardless of its proportion in the grain. Mixed mixture (Jensen, 1996) such as improved yield (Esmaeili *et al*., 2011; Sadeghpour and Jahanzad, 2012) and increased biological activities in the soil and reduced Pest attack (Smith and McSorley, 2000). The occurrence of legumes in cropping systems is an opportunity to improve soil fertility and crop yields, to meet nitrogen requirements through its atmospheric symbiotic fixation (Hauggaard-Nielsen *et al*., 2001), Leguminous plant roots and bacteria have the ability to alleviate the burden of expensive and dangerous agrochemicals (Haiyambo and Chimwamurombe, 2018). The introduction of cereal-legume crops aim at improving the nutritional autonomy of livestock, to strengthen the sustainability of production systems, to reduce the costs

Department of Ecology and Vegetable Biology, FSNV, Ferhat Abbas University, Setif -1, Algeria.

Corresponding Author: C. Benide, Department of Ecology and Vegetable Biology, FSNV, Ferhat Abbas University, Setif -1, Algeria. Email: beniderchafia@gmail.com

How to cite this article: Benider, C., Laour, S., Madani, T., Gundouz, A. and Kelaleche, H. (2021). The Effect of Cereal-legume Intercropping Systems on the Cereal Grain Yield under Semi-arid Conditions. Agricultural Science Digest. 41(4): 610-614. DOI: 10.18805/ag.D-346.

Submitted: 17-03-2021 **Accepted:** 29-07-2021 **Online:** 05-10-2021

generated by low food self-sufficiency, it allows a success of organic systems and helps 'obtaining good economic results to protein self-sufficiency. However, it relies on a judicious choice of plant material (Abbas, 2018). Our work is intended to analyze the response to dual exploitation of intercrops systems and their ability to produce forage and grain, thus the efficiency of cereal-legumes intercropping on the qualitative and quantitative improvement of yield of cereals.

MATERIALS AND METHODS

Study of experimental site

This experiment was conducted on the site of experimental farm of Setif University subordinate to Laboratory for Valorisation of Natural Biological Resources (LVRBN), during the cropping season (2019/2020), geographical coordinates are latitude 36°11′ Nord and longitude 5°21′ Est. The climate in the region of Setif (Algeria) is a Mediterranean semi-arid continental type with very low winter temperatures and very high summer temperatures 27°C. In autumn and spring, temperatures are swe*et al*though frosts are frequent at the beginning of spring. The average rainfall is 400 mm/year. The physicochemical composition shows a tonic-globony texture, a lumpy structure and a high overall calcareous content of 33.50 to 35 add 4 per cent in all plots at base water (pH=8.1 to 8.5) (Chenaffi 1997, Belarbi 1998). The organic matter content was between 0.08 and 2.69%. The assimilative content of phosphorus is between 17.17 and 36.04 ppm; the content of nitrogen (0.07 per cent) is low (Belarbi, 1998).

Two crossed passes of cover crop are used before planting, after the first autumn rains (September and October), to reduce weed infection and get good seed bed. No fertilizatizer was applied and mechanical weeding was done. On 12/16/2019 the crops were sown by manually as per the technical program, each plot have five rows at the spacing of 20 cm apart metre long.

The plant material consisted of Tritical (*Tritico-secale Wittmack*), Barley (*Hordeum vulgare*), Oat (*Avena sativa* L.), pea (*Pisum sativum)*, common Vetch (*Vesce commune*).

The treatments studied were consisted of cereal-legume are barley/pea, tritical/pea, oats/pea and barley/ Vetch, triticale/ Vetch, oats/ Vetch, sown at half dose of recommended seed rate (50% of cereal and 50% of legume). And here cereal monocrops of barley and tritical dose of seeding is 125 p/m² on the other hand oats is 60 p/m^2.

Followed and notations

The total add dry matter accumulated in the air part in crop systems. The vegetation sampled is mowed end but early June the ideal time of harvest is in the middle of the pasty stadium (about two to three weeks before the grain harvest). At this time, plants have dry matter content (MS) of 35% (Wyss and Arrigo, 2015) of a segment of 0.5 m long, by elementary parcel. The weight of the dry matter is determined after passing at the oven at a temperature of 85°C for 48 hours before measurement of dry matter.

At maturity, the grain yield and its performance components are estimated, these components are determined from the boots harvested on a segment of 1 m long. The total yield and biomass of these samples are used for the calculation of the harvesting index and the count of the ears. The number of spikes / m² is determined by counting of the spikes from the same mature kother of a linear 1 m and the average weight of 1000 grains (TKW). Maturity is determined the height of the rods, the length of the collar of the epi and the length of the flag sheet is estimated from a sample of 5 plants in early July with complete maturity.

Statistical analysis

All data were evaluated using variance analysis (ANOVA) (Costat 6.400, 1998). The LSD was used to compare their means at chance ranges of 0.01 per cent and 0.05 per cent. The key factor analysis PCA also represents the significance of the greatest contributor to overall improvement in each defining axis. The statistical program is used for the hierarchical clustering analysis (AHC).

RESULTS AND DISCUSSION

The collected data were evaluated more than once according to the variance methodology analysis of the variables measured by the different culture system has the shape shown in Table 1. Height of stem changes between the culture modes used, goes through a maximum of 89 cm for go down to the value of 44.33 cm. The difference is significant at the threshold of 5% probability. The highest of thatch of the intercopping of the pea; AP intercrops with heights equivalent of 89.81 cm, the height of large straw is a desirable characteristic in the semiarid zone, following its beneficial effects during dry years. These effects are attributed to the storage and transfer capacity of glucid substrates for grain finish (Bahlouli *et al*. 2005; Annichiarico *et al*. 2005). This contribution of the height of the stubble with the substrates stored at the level mainly of the last between node and the spike neck minimizes the decline in grain yield under stress (Blum, 1988) in this context the rate of accumulation of matter dry in pre an thesis and the ability to translocation of the assimilates stored in the rod play an important role in adapting the variety to climate constraints (Siddique *et al*. 1989).

Table 1: ANOVA analysis, mean values of the steam height SH (cm), the flag leaf length FLL (cm),t he accumulated dry matter DMP (t/ha), Grain yield and thousand kernels weight TKW (g).

	SH	GY	TKW	FLL	DMP
SH	1	0,43	0,34	0,78*	0,29
GY		1	0,54	0,18	0,94*
TKW			1	0,63	0,48
FLL				1	0,01
DMP					1

Mean values of the same letter in the same column at P<0.05 are not dramatically different depending on the least important differential measure (LSD).

The analysis of the variance of the height of the flag leaf indicates significant differences. The height of the flag sheet varies from 16.66 to the oat/peas intercrops (AP) at 6 -7 cm in the three pure crops Who represents the witnesses lasts last with, significantly, the lowest. The analysis of the HS relationship shows that the height of the thatch significantly correlated positively with the height of the flag leaf r =0,78 (Table 2) and (Fig 3), FLL significantly correlated positively with the TKW r = 0.63 (Table 2).

The meaning of the culture system effect indicates that the dry matter produced significantly enchanced in different systems. The dry matter at harvest, grain and straw yield was significantly influenced due to nitrogen (Uma Maheswar Reddy *et al*. 2020). The comparison of dried materials accumulated at the stage (cereal: pasty and legume: fine flowering). The results indicate that the ability of the triticale / peas intercropping (TP) 4.50 t /ha, to produce more dry matter than its pure triticale culture (T) and the other crop system. They are consistent with what is reported in the results in Algeria (Benider *et al*. 2017), in Turquie and in Tunisia using the mixed crops of triticale and variety of peas (Hechmi, 1999) and in Swiss (Clerc *et al*. 2015). However the barley/pea mixtures (OP) inferiority shows for the DMP variable by contribution to its sol crops barley (O). Two controls O and T Form the same capacity group of the dry matter.

The grain yield of triticale was in intercropping with peas or sol crop and barley / pea's intercrops form the best group for grain production. The grain yield of barley in the intercrops with the pea increased considerably signifiant as monocrop, the concord with the results (Sahota *et al*. 2012) reported when barley and pea were grown as sole crops, the grain yield of barley when increased, particularly when cultivated without the N applied. In the other hand, if the back were combined with the vet, the grain yield was smaller than its own grain yields. The intercrops of oats and its corresponding sol crop shows the lower group that the group whose vetch is mixtures with the one or triticale. The grain yields of the cereals of intercropping with the pea are greater than that of the corresponding sol treatments. Analysis of the performance relationships with components, shows that the capacity of accumulating. The dry matter is correlated strongly and substantially with yield r = 0.94 (Table 2) and (Fig 3). Moreover, the grain yield is positively associated with the TKW r = 0.54 (Table 2).

The weight analysis of TKW shows significant differences between the different cultivation systems the TKW varies between 49.33 and 23,33 g. The group of tritical intercropping of peas or vetch (49.33-44.83 g) has a higher TKW than the mono-crop of triticale control. The TKW of the intercropping systems improve significantly than the TKW of the cereal grains as a sol crops, that explained by the presence of legumes. The Barley-Pea intercrops increased grain returns, protein concentrations in grain and the resilience of economic returns, such as improved yield and improved yields (Esmaeili *et al*. 2011; Sadeghpour and Jahanzad, 2012; Sahota *et al*. 2012). The Hierarchical clustering analysis (AHC) for traits show that the five variables examined are separated into 03 groups (Fig 1).

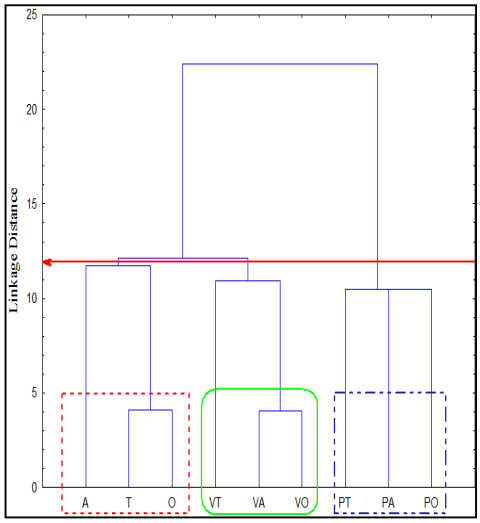

Fig 1: Similarity levels of estimated variable Using Hierarchical clustering.

Table 2: Simple correlation coefficient between variables studied.

Sys	SH (cm)	FLL (cm)	DMP (t/ha)	GY (t/ha)	TKW (g)
PO	80 (a)	13,33 (abc)	4,50 (b)	2,73 (a)	39 (b)
PA	89 (a)	16,66 (a)	2,16 (de)	0,99 (cd)	36 (bc)
PT	81 (a)	14,00 (ab)	5,60 (a)	3,32 (a)	49,33 (a)
VO	45,66 (b)	6,50 (ef)	3,36 (c)	1,36 (bc)	33,5 (cd)
VA	47 (b)	10 (cde)	2,56 (cde)	0,44 (d)	34,33 (bcd)
VT	44,33 (b)	10,66 (bcd)	3,16 (cd)	1,73 (bc)	44,83 (a)
O	58,66 (b)	6,00 (f)	4,56 (ab)	1,88 (b)	33,66 (cd)
A	52 (b)	6,33 (ef)	1,66 (e)	0,48 (d)	23,33 (e)
T	60,33 (b)	7,00 (def)	5,23(ab)	3,03 (a)	30,33 (d)
Mean	62,00	10,05	3,46	1,77	36,03
Min	44,33	6,00	1,66	0,44	23,33
Max	89,00	16,66	5,6	3,32	49,33
LSD 5%	16,31	3,94	1,091	0,84	5,21

*Significant correlation at 5%.

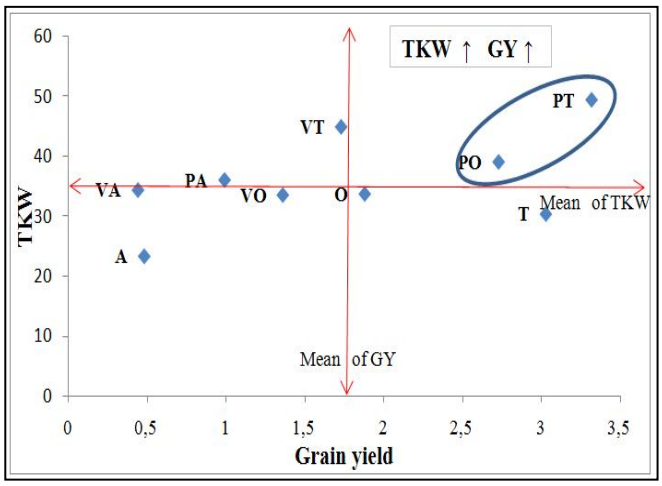

Fig 2: Behavior of different systems in relation to GY and TKW.

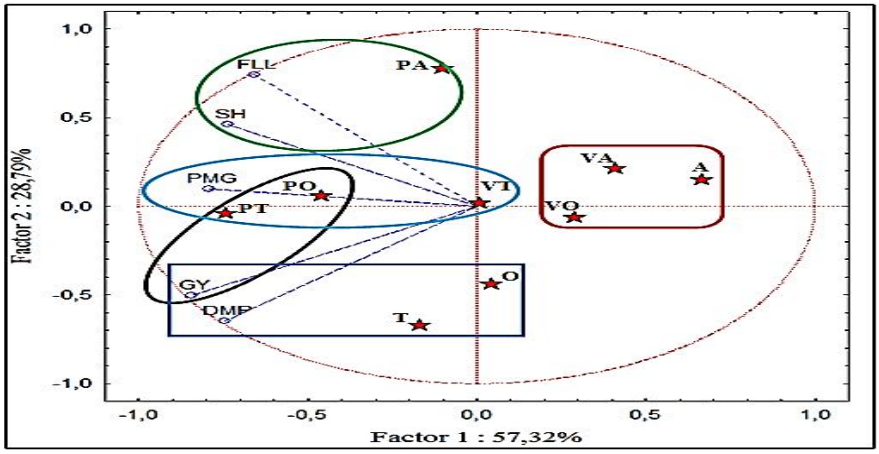

Fig 3: Biplot of variables and systems crop.

The first group consisted of sol crops (A, T and O) the group 2 included cereal-vetch intercrops (OV, TV and AV) and the group 3 consisted by the cereal-peas intercrops (PT, PA and PO). These three groups differ especially for the characteristics relating to the height of the rods, height sheet Flag, ability to accumulate dry matter, grain yield grains and TKW. Baghdadi (*et al*. 2016) reported that these intercrops were productive systems than corn monocrop. Intercropping systems increased the quality and add over single cultivation systems. PT and OP intercropping characterized by better qualitative and quantitative yield of cereal positively correlated with grain yield and TKW (Fig 2).

Principal component analysis (PCA) shows the eigenvalues of the five components, they alone accumulate 86.11% of information on variability show PT, PO, O and T characterized by the highest grain yield and the accumulated dry matter, that PT, PO with VT were positively connecting to TKW, unlike PA positively correlated with the FLL and SH and negatively correlated with yield grain and the accumulated dry matter. The VA, VO and A which have the lowest add. The relations of measured traits and system crops tested with 5 variables components are graphically summarized in Fig 3.

CONCLUSION

The findings of this study proved the best function to increase efficiency for the cereal-legume intercropping systems. In view of the evolving environment, this device has tremendous potential to increase food production on the marginal and polluted soils of developed countries. In addition, the both intercrops triticale/pea and barley/pea are the best intercropping systems with highest grain yield and thousand kernels weight. Barley/pea intercropping change has proven successful with respect to protein enhancement in heavily infested weed and poor N supply intercropping systems. In addition, the intercrop triticale/pea showed significant effects on the grain yield and the average weight of 1000 grain which indicate the efficiency of using like this intercrop to improve the productivity and the quality of triticale grains.

ACKNOWLEDGEMENT

In this study the authors wish to thank to all workers at Department of Ecology and Vegetable Biology, FSNV, Ferhat Abbas University, Setif, Laboratory for Valorisation of Natural Biological Resources (LVRBN) and the Technical Institute of Field Crops (ITGC) Setif.

REFERENCES

Abbas, K. (2018). Pois-triticale : un fourrage prometteur pour sécuriser les systèmes d''élevage des zones céréalières semi-arides d'Algérie, Journées AFPF. 21: 220-221.

Abbas, K. and Abdelguerfi, A. (2005). Perspectives d'avenir de la jachère pâturée dans les zones céréalières semi-arides. Fourrages. 184 : 533-546.

Abdelaal, H.K., Bugaev, P.D. and Fomina, T.N. (2019). Nitrogen fertilization effect on grain yield and quality of spring triticale varieties. Indian Journal of Agricultural Research. 53(5): 578-583.

Annichiarico, P., Abdellaoui, Z., Melouki, M. and Zerargui, H. (2005). Grain yield, straw yield and economic values of tall semi dwarf durum wheat cultivars. Algeria. J. Agric. Sci. 143: 54-64.

Baghdadi, A., Ridzwan. A.H., Radziah, O., Martini, M.Y. and Atashgahi, A.R.M. (2016). Productivity, relative yield and plant growth of forage corn intercropped with soybean under different crop combination ratio. Legume Research. 39: 558-564.

Bahlouli, F., Bouzerzour. H., Benmahammed, A. and Hassous, K.L. (2005). Selection of highs yielding and risk efficient Durum wheat (*Triticum durum* Desf.) cultivars under semi-arid conditions. Pak. J. Agro. 4: 360-365.

Belarbi, N. (1998). Comportement et évaluation de quelques espèces fourragères dans la région de Sétif, thèse d'ingénieur INA, Alger, 27p.

Benider, C., Bouzerzour, H., Madani, T. and Guendouz, A. (2017). Reflectance estimation in cereal/pea intercropping system based on numerical images analysis method. Indian Journal of Agricultural Research. 51(6): 615-618.

Blum, A. (1988). Plante Breeding for Stress Environments. CRC Press. Eds, 223.

Boateng, S.K., Tetteh, R. (2020). The effect of leguminous cover crops on growth and yield of garden eggs. Indian Journal of Agricultural Research. 54(2): 252-255.

Borah, N., Sarma, A., Sarma, D., Bhattacharjee, A. and Bordoloi, D. (2020). Studies on character association and causal relationship of seed yield and its components in early maturing genotypes of pigeon pea (*Cajanus cajan* L). Indian Journal of Agricultural Research. 54(5): 661-665.

Chenaffi, H. (1997). Optimisation de l'apport d'appoint d'eau sur trois variétés de blé dur (*Triticum durum* Desf.) à différents stades. Cas des hautes plaines Sétifiennes, thèse magister INA, Alger, 64.

Clerc, M., Klaiss, M., Messmer, M., Arncken, C., Dierauer, H., Hegglin, D. and Bohler, D. (2015). Amélioration de l'approvisionnement en protéines indigènes avec des cultures associées, Rech. Agron. Suisse. 6: 508-515.

Costat 6.400, (1998). Copyright©1998-2008, CoHort Software798 Lighthouse Ave BMP 320, Montery,CA 93940, USA, Email: info@cohort.com, URL: http://www.cohort.com.

Drevon, J.J., Ounane, M.S. (2009). Efficacite d'utilization du phosphore et fixation symbiorhizobienne d'azote dans la culture du haricot, INRA, Paris, 6p.

Esmaeili, A., Sadeghpour, A., Hosseini, S.M.B., Jahanzad, E., Chaichi, M.R. and Hashemi, M. (2011). Evaluation of seed yield and competition indices for intercropped barley (*Hordeum vulgare*) and annual medic (*Medicago scutellata*). International Journal of Plant Production. 5: 395-404.

Haiyambo, D.H. and Chimwamurombe, P.M.(2018). Isolation of the *Azospirillum* species from the Rhizosphere of the leguminous *Bauhinia petersiana in* north-eastern Namibia. Jordan Journal of Biological Sciences. 11: 347-353.

Hechmi, N. (1999). Etude comparée de quelques associations annuelles graminée-légumineuse en zone humide de Tunisie. Fourrages. 159: 269-275.

Hauggaard-Nielsen, H., Ambus, P. and Jensen, E.S. (2001). Interspecific competition, N use and interference with weeds in pea-barley intercropping. Field Crops Res. 70: 101-109.

Jensen, E.S. (1996). Grain yield, symbiotic N_2 fixation and interspecific competition for inorganic N in pea-barley intercrops. Plant and Soil. 182: 25-38.

Meena, K.K., Tiwari, R. and Tiwari, S. (2011). Salt-tolerant rhizobacteria-mediiated induced tolerance in wheat (*Triticum aestivum*) and chemical diversity in rhizosphere enhance plant growth. Biol Fertil Soils. 47: 907-916

Sadeghpour, A. and Jahanzad, E. (2012). Seed yield and yield components of intercropped barley (*Hordeum vulgare* L.) and annual medic (*Medicago scutellata* L.). Australian Journal of Agricultural Engineering. 3: 47-50.

Sahota, T., Sukhdev, S. and Malhi (2012). Intercropping barley with pea for agronomic and economic considerations in northern Ontario. Rev: Agricultural Sciences. 3: 889-895.

Siddique, K.H.M., Belford, R.K., Perry, M.W. and Tennant, D. (1989). Growth, development and light interception of old and modern wheat cultivars in a Mediterranean-type environment. Aust. J. Agric. Res. 4: 473-487.

Smith, H.A. and McSorley, R. (2000). Intercropping and pest management: A review of major concepts. American Entomologist. 46: 154-161.

Pattison, R.J. (1979). End of a Mission Report, MARA/FAOIN-GnUfi7, Algerie.

Uma Maheswar Reddy, M., Roja, M., Reddy, M.D. and Saurav B. (2020). Effect of nitrogen and phosphorus management on growth and yield of foxtail millet (*Setaria italica* L.) during summer season in Odisha, India. Indian Journal of Agricultural Research. 54(2): 242-246.

Wyss, U. and Arrigo, Y. (2015). Qualité des ensilages plantes entières de triticale, d'avoine et de pois fourragers. Recherche Agronomique Suisse. 6: 152-159.