"Evaluting Physiological Adaptations and Yied Performances of Fave Leguminous Cover Crops in Semi Arid Condition of Algeria"

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Abstract. *Forage legumes are produced to meet the quantitative and qualitative needs of ruminant food; as they are considered the richest in total nitrogenous matter, this study assesses the physiological traits and yield performance of five leguminous cover crops—Sefrou forage pea, Messire proteaginous pea, Vicia narbonensis (vetch), Lathyrus ochrus, and Beni Mstina faba bean—in the semi-arid highlands of Sétif, Algeria. Conducted during the 2021-2022 season at Boutaleb, this research aims to identify varieties with resilience to water and thermal stress under low-rainfall conditions (323.2 mm cumulative). The results indicate a significant variability in the tolerance capacity of the tested varieties the local weather condition, the protein pea gave a rate of (53.66%) plant emergence, the Lathyrus had reached (55cm) of height, biomass production (PF 175.26 and PS 16.16) g/m2, relative water content, and leaf area. The Sefrou variety demonstrated high biomass yield, while Lathyrus ochrus achieved optimal germination and height. Vetch exhibited the greatest leaf area (49 cm²) and highest relative water content (76.14%), signifying robust drought tolerance. The faba bean gave the highest specific weight of leaves by (0.04g/m2).the effect of membrane stability index was good for all tested varieties. This study underscores the potential of leguminous crops in semi-arid agriculture, providing insights for sustainable forage crop selection to enhance productivity and ecosystem stability in similar environments.*

Keywords: *Forage legumes, nitrogen, semi-arid, biomass, yield.*

INTRODUCTION

legumes play an essential economic role. The ONU has designated 2016 as the "International Year of legumes" to raise awareness of their nutritional and agro-ecological interest in maintaining sustainable agriculture and biodiversity in the face of climate change.

In recent decades, Forage legumes have become increasingly vital in the decades, in semi-arid areas for their ecological benefits and nutritional value. They also play a role, in promoting agricultural practices. (Baumont et al., 2009). Forage legumes are known for their high protein content and nitrogen-fixing abilities, which contribute significantly to soil fertility and reduce the need for synthetic fertilizers (Graham & Vance, 2003). The nutritional profile of forage legumes makes them a preferred feed source, providing a high-value option for ruminant diets compared to grasses (Benyoucef, 1972). However, semiarid conditions regions, with dry climates like this one maintaining the right conditions can be tough due, to limited water resources and unpredictable temperature changes. These factors can affect how well legumes grow and the amount of biomass they produce. (Hamli, 2015; Clarke et al., 1989).

Algeria's semi-arid regions, characterized with rainfall and extreme temperatures require choosing legume types that can thrive in these climates. (Bouzrara & Ould Ferroukh, 2010). Numerous research studies have highlighted the impact of legume species on enhancing the durability and efficiency of forage systems, in dry regions. (Khaldoun et al., 2000; Abdelguerfi, 2002). These legumes not only contribute to soil stabilization and biodiversity but also improve forage quality, essential for maintaining livestock productivity in arid environments (Jensen et al., 2012). Legumes ability to retain water levels and keep their membranes stable during periods of water stress is vital, for their survival and productivity, in areas. (Clarke et al., 1989).

In this context, evaluating physiological traits such as biomass yield, relative water content, and leaf area in forage legumes provides insights into their adaptability and resilience to environmental stressors (Campillo et al., 2010; Jarrige et al., 1995). This study focuses on five varieties of Fabaceae—Sefrou and Messire peas, Vicia narbonensis, Lathyrus ochrus, and faba bean—to assess their performance in Algeria's semi-arid highlands. Research was carried out in Boutaleb, near Sétif with the goal of pinpoint the types of crops that not produce yields but also possess physical characteristics that are beneficial for thriving and being productive in areas, with limited water and high temperatures. (Klein et al., 2014; Renaud, 2002).

Studying how these legumes adapt can help create lasting forage systems and boost resilience in the face of changing climates. (Alexandra Jorge, 2018). This study aims to support the work towards improving the yield of forage legumes in the arid areas of Algeria. This alignes, with objectives, for farming practices and the preservation of resources. (Jensen et al., 2012).

This paper aims to evaluate the physiological responses and yield performance of five leguminous cover crops in Algeria's semi-arid highlands, focusing on their adaptation to water and thermal stress. By analyzing traits such as relative water content, membrane stability, biomass yield, and leaf area, this study seeks to identify legume varieties with high resilience and productivity in resource-limited environments. The originality of this work lies in its targeted assessment of legume adaptability under semi-arid conditions, specifically in the Boutaleb region, where limited studies have focused on optimizing forage crop selection for arid and semi-arid climates. This research Investigating this area offers knowledge for forage cultivation efforts that align with the overarching goals of bolstered agricultural resilience and improved legume utilization, in tough environmental conditions.

MATERIAL AND METHODS

An experiment was conducted Boutaleb location 80km southern SÉTIF (Fig.1), during the 2021/2022 season The site is located at a latitude of 35° 39′ 37″N, a longitude of 5° 19′ 16″ E and an altitude of 900 m above sea level. Total annual rainfall in the year 2022 was approximately 323,2mm with a monthly average of 83,8mm. The minimum and maximum average temperatures were -1,1 °C and 30,7 °C, respectively.

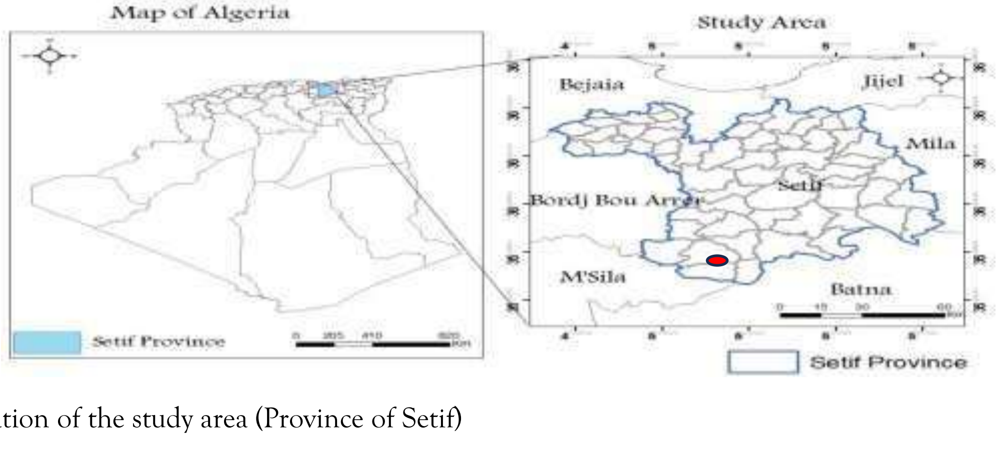

Figure 1. Location of the study area (Province of Setif)

Vegetative growth

05 varieties of Fabaceae: forage pea: Sefrou (Pisum Sativum L), proteaginous pea: Messire(Pisum Sativum L), vecht :(Vicia narbonesis), (Lathyrus ochrus) and faba bean: Beni Mstina (Vicia faba.l.)The varieties are multiplied and distributed by the Seed Demonstration and Multiplication Farm of the Technical Institute for Major Crops (FDMS, ITGC) in Setif, The analyzed parameters are carried out at the laboratory of valuation of natural biological resources : exploitation of resources and, management of space.

The measurements

Fresh material yield (FMY) Sampling on a surface of 1 m² in each elementary plot, mowed at a height of 5 cm from the ground, immediate weighing of the harvested quantity for the estimation of the yield of the green matter in each 1 (g/m²), and thereafter this quantity is reported in t/ha (Gate, 1987).

Dry matter yield (DMY) The samples of the fresh material are put in the ventilated oven (fodder oven) for 48 hours at a temperature of 80°C; the quantity of dry matter is weighed as soon as the oven is released,and this quantity is then reported in (g/m²) (Gate, 1987).

Leaf surface (LSW) The surface of the standard sheet is estimated on a sample of 03 sheets by a plot line to determine the surface with a mobile phone camera. the distance between the camera and sheet is 0.20 m. several have been taken to obtain variations.The images were stored in a JPEG (Joint Photographique Expert Groupe). Before being downloaded to a PC computer and analyzed using Mesurium Pro (version3.3) software that measures the size and surface ofthe sheets in cm².

Sheet specific weight (SSW) The specific weight of the standard leaf (SSW, mg/cm²) is determined by the ratio between the dry weight of the sample of 3 (mg) on the leaf surface of this sample (cm²).Dry weight was determined by passing the sampled leaves through an oven for 24 hours at 70°C:

SSW (mg/cm2) = SWF (mg)/SF (cm²)

Relative water content (RWC) The sampled leaves, 2 seedlings per variable, per repetition (3 repetitions) and per treatment are directly weighed to have the fresh weight (FW) then immersed in test tubes containing 10 ml of distilled water. Samples are refrigerated for 24 hours to allow for complete hydration. After rehydration, the leaves are weighed for turgid weight (TW) and are placed in an oven at a temperature of 70°C for 24 hours to obtain the dry weight (SW). Relative water content is determined using the formula (Equation 1), reported by Teulat et al., (1997) and attributed to Barrs and Weatherley (1962): **RWC (%) = [(FW - SW)/ (TW - SW)] *100**

Membrane thermo stability (MTS) The cell integrity test called thermo stability membrane (MTS) is performed on the last two fully developed sheets that are washed with running water. The leaves are cut into 1cm long pieces. A sample of 10 pieces of the leaf blade is put into a test tube and washed by three with distilled water to remove adherent dust that may affect the test results. Three tubes are used per treatment. To each tube, 10 ml of demineralized distilled water is added. The tubes, thus treated, are periodically manually stirred and left at the laboratory room temperature. A first reading is made (EC1) with the conductivity meter, 24 hours later. The tubes are then put in the bath The stability of the cell membrane with respect to thermal stress is estimated, according to the procedure described by Baji et al., (2001), as follows:

MTS (%) = 100*[1-(EC1/EC2)] Statistical analyses

The data was analyzed using analysis of variances (ANOVA) following the methods outlined by Dospekhov (1985). Significant ranges (LSRs) were utilized to compare the treatment effects as, per Duncans approach from 1955 with a significance level of 5%.

RESULTS AND DISCUSSION

Germination and early development of seedlings (table. 1)of (vetch and lathyrus) a delay of 15 to 30 days for other varieties of the critical stagesthat determine the potential yield in adverse environments affect early flowering and early pod formation in lathyrus and late in field and vetch. plant losses at sunrise are greatest in field beans and lathyrus are explained by the dose of sowing and variations are probably due to seed quality (Germinative Faculty) and the ability of each species to adapt to the agroecological conditions of the production environment.

Table 1.of Germination and early development of seedlings

varieties	Date of emergenses	Date of flowering	Date of formation of pods
Forage peaSefrou (Pisum Sativum L)(**FP**)	05-03-2022	15-04-2022	28-04-2022
Proteagineux peaMessire (Pisum Sativum L) (**PP**)	09-03-2022	20-04-2022	29-04-2022
Lathyrus (Lathyrus ochrus)(**LO**)	21-02-2022	05-04-2022	14-04-2022
Vetch: (Vicia narbonesis) (**VN**)	20-02-2022	15-04-2022	07-05-2022
Faba bean (Vicia faba.l.)(**FB**)	20-03-2022	06-04-2022	29-04-2022

The highest stems are present in lathyrus and vetch with (55 cm). However, the smallest stems are noted in other varieties their height between (40 and 45cm). The results obtained are explained by the low rainfall recorded during the stage of ascent and high temperatures (sums of high temperatures), which negatively influenced the height of plants. Vegetation height is an important "varietal" characteristic which, under semi-arid conditions, becomes a determinant of grain yield (Bouzerara and Ould Ferroukh, 2010).

Dry matter yield

Test of ANOVA(Table. 2) effect of dry matter shows two groups (a) include Faba beanwith the minimum value 4.73 g/m² and the second group (b)includes (FP, PP, LO and VN) performing sefrou with maximum value of 16.16 g/m². The differences in biomass accumulation can be explained by the use of environmental availability including soil moisture, nitrogen and radiation intercepted more by differences in the number of plants installed. Indeed, to (Ruiter, 2001). forage quality is influenced by plant phenological development. However, forage quality decreases with maturity (Sanderson and Wedin., 1989; Bruinenberg et al., 2002; Benider et al., 2017). The age and maturity stage, the fraction of green leaves in the biomass produced has long been associated with forage quality (Fick et al., 1994). The leaves, seat of photosynthesis, are the organs richest in proteins, and other nutrients and the poorest in walls and parietal constituents (Jarrige et al., 1995).

Leaf surface

According to the results obtained the surface of the leaves of the Vesce is the most efficient with a maximum average of 49 cm². minimale celle valeur de PP: 9.77 cm ². A high standard leaf area is desirable because it is related to grain yield (Rahim et al., 2006) Crop productivity depends on the ability of crop cover to intercept incident radiation. The essential function of the foliar surface, the architecture of the vegetation cover and the efficiency of converting the energy captured by the plant into biomass (Campillo, 2010).

Sheet specific weight (ISW)

The results indicate that the specific weight of effective leaves is that of Fev varieties whose maximum average value (0.04 g/cm²). While the minimum average in peas sefrou (0.008 g/cm²). The recorded variations explain the reduction of photosynthesis, linked to the decrease of the foliar water potential, depends both on the closure of the stomata, resulting in a decrease in the conductance at the diffusion of CO2 and a biochemical limitation of chloroplast to fix CO2 (Zaman-Allah et al., 2011).

Relative water content (RWC)

The water content of the leaves provides information on the relative turgor of the tissues and among the stress tolerance evaluation criteria. To appreciate the water state of the plants tested. Analysis of variance induces a significant effect of relative water content for the tested varieties Relative water content is reported as a good indicator of leaf water deficit, it directly reflects the balance between the water supply to the foliage and the rate of transpiration (Lilley and Ludlow, 1996). Clarke et al, 1989 found that a low rate of water loss from excised leaves is positively correlated with yield performance under water stress conditions. (Mebarki et al.,2021) suggest the use of the relative water content and water loss rate of excised leaves as criteria for identifying water stress tolerant genotypes

Membrane thermo stability (MTS)

The results indicate that(figure.2)revealed that, a positive correlation was observed between dry matter yield and membrane stability, with a coefficient of determination of r^2=0.758. there were two homogeneous groups. Varieties in the same group except faba bean in 2nd group has min value to 73.120% High membrane stability in forage woods. PP has 92.42%; FP: 91.03%. Thus, justifying its strong potential to adapt to local climatic conditions by tolerating rising and delayed spring temperatures find that cell membranes are usually the first targets of stress that causes damage The integrity test of the cell membrane is based on the quantification of the electrolyte that is lost by the disks of the sampled leaf tissue, after imposition of heat stress. The amount of electrolyte lost by the cell is a measure of the degree of tolerance of high temperatures (Fokar et al.,1998) ;(Ibrahim and Quick, 2001) ;(Pask et al., 2012). Resistance to heat stress is closely related to the water supply of the plant. Foliage water retention capacity is suggested to assess plant resistance to thermal and water stress of any dry-area germplasm (Ritchie and Henry 1990). The plasma membrane thermo stability test is a technique that promises in terms of progress in selection for water and thermal stress tolerance (Hamli et al., 2015) **Table 2.** Of tests of between-subjects effects

	DMY	ISW	RWC	MTS
varieties	FB 4.73(a)	VN0.31(a)	LO 67.41(a)	FB73.11 (a)
	PP 13.33(b)	PP 0.33(a)	FP 76.13(ab)	VN 88.74(b)
	VN 15.56(b)	LO0.33(a)	FB74.42 (ab)	LO89.80 (b)
	LO16.10 (b)	FB0.53(b)	PP 64.88(b)	FP 91.03(b)
	FP16.16 (b)	FP 0.66(b)	VN 54.85(b)	PP92.60 (b)
Sig	0,224	0 ,184	0,359	0,399

L'anova montre des différences significatives entre variétés au seuil de 5% pour les variables : dmy, lsw, rwc and mts

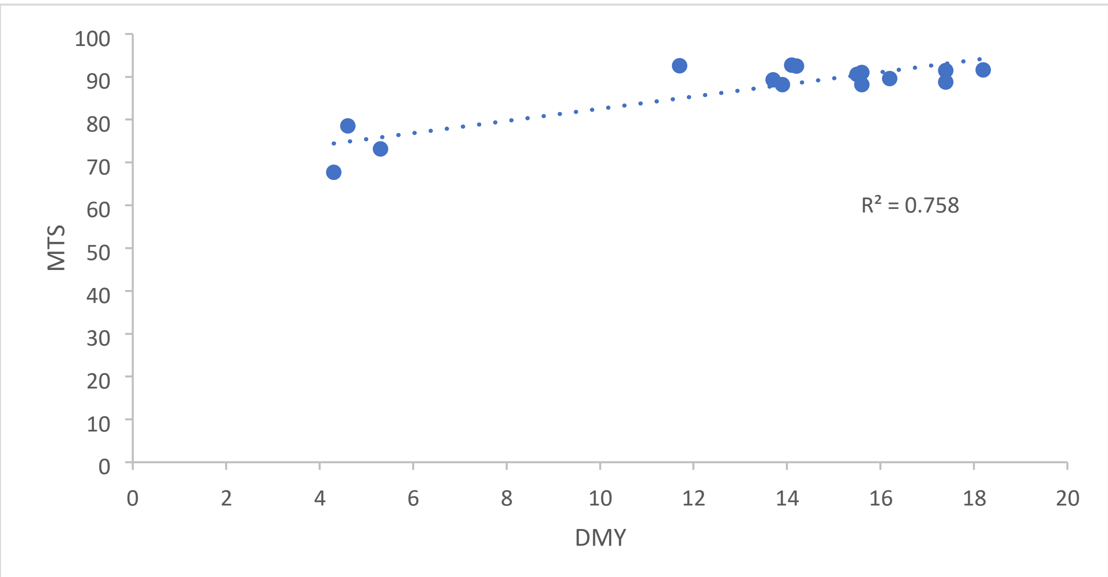

Figure 2. correlation was observed between dry matter yield and membrane stability

CONCLUSION

The results of this study achieved our primary objective, which was to explore the responses of certain legumes to physiological factors related to their ability to tolerate water and thermal stress in the semiarid region of Sétif, Algeria.

The trial revealed significant differences among the studied parameters. The forage peas Séfrou and Messire demonstrated good performance regarding the measured physiological parameters. In contrast, Lathyrus exhibited excellent germination capacity, as well as good yields in both green biomass and dry matter. Vicia sativa, on the other hand, achieved the greatest height. Faba bean produced favorable results in terms of leaf area, even surpassing peas in leaf specificity. Vicia sativa also showed good yields in green and dry biomass, along with a superior leaf area.

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