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異なる気温および土壌水分条件下での数種の食用マメ科作物の主根の生長

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Tap Root Growth of a few Food Legume Species under Different Air Temperature and Soil Moisture Conditions

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Introduction

In a life cycle, a crop plant usually experiences the changes of environmental factors such as growing temperature and soil moisture conditions, but the information about their effects on the crop growth is limited especially for food legume species. This experiment was, therefore, carried out to study the effects of limited soil moisture conditions and different growing temperatures on the growth of a few food legume species with especial emphasis on tap root elongation.

Materials and Methods

Three species namely, chickpea (*Cicer arietinum, winter species)*, lentil (*Lens culinaris,* winter species) and cowpea (*Vigna unguiculata,* summer species) were grown in slightly slanted half-split PVC tubes filled with loamy sand soil during autumn (Oct. 8 to Nov. 25, 1993) under glass house conditions. Two genotypes per species were grown with four replications. Soil moisture stress was induced by withholding irrigation after seed sowing while control plants were irrigated every week. The positions of tap root tips were marked every day on the clear acrylic plate fixed on the cut face of the tubes, transpiration and photosynthetic rate were measured just before sampling, and shoot growth parameters were determined on the sampled plants. Temperature effects were evaluated by comparing the data of plants grown in two different seasons, *i. e,* irrigated plants in this autumn experiment and those of spring experiment previously reported[1]).

Results and Discussion

1. Effects of limited soil moisture conditions

The amount of water lost by evapotranspiration from the tubes' soil, estimated from Fig. 1, was greatest in chickpea followed by cowpea and lentil which reflected the differences in their root system development. In the non-irrigated plants, transpiration rate was reduced but photosynthetic

rate was slightly promoted which resulted in increased water use efficiency (Fig. 2) indicating that the water stress induced by this treatment was mild. Tap roots growth (Fig. 3) were scarcely affected by the treatment (except cowpea ; HAF-16). In contrast to the root growth, shoot growth evaluated based on leaf area, shoot dry weight and plant height were promoted by the treatment (Table 1).

2 . Seasonal variation

Mean air temperature was 19.8°C in spring and 15.6°C in autumn experiment. Tap root elongation was faster in spring for all species (Fig. 3). Fluctuation in tap root elongation rate also varied with growing season and it was larger in spring. Interspecifically, these fluctuations were larger in cowpea than chickpea and lentil. Regardless the growing season, correlations between tap root elongation rate and daily mean air temperature was stronger in cowpea than chickpea while this relationship in lentil was much weaker or absent (Fig. 4). Plant growth was generally reduced in autumn than that in spring (Table 2). In tap root elongation, the reduction was less for chickpea and lentil than cowpea whereas shoot growth reduction was more pronounced for lentil and chickpea than cowpea.

These results suggest that the mild soil water stress scarcely affected the tap root growth but slightly promoted the shoot growth and water use efficiency. Seasonal variations in tap root growth were less for winter species (chickpea and lentil) than the summer species (cowpea), and the tap root elongation rate was temperature dependent for the summer species while for the winter species it was much less dependent on or independent from growing temperature.

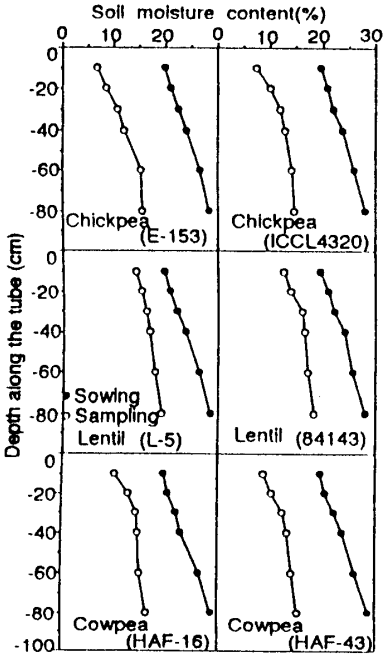

Fig.1. Soil moisture content (%) at sowing and sampling time in non-irrigated soil.

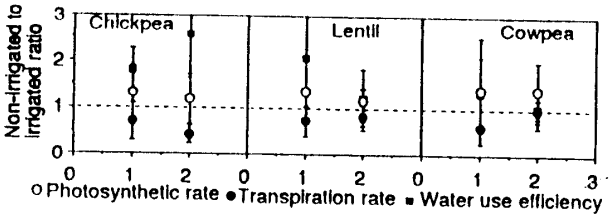

Fig.2. Ratio of the physiological characters of plants grown under two soil moisture conditions (non-irrigated : irrigated)

Table 1. Ratio of growth parameters of non-irrigated to irrigated plants.

Species	Genotypes	Root elongation rate	Leaf area	Shoot dry weight	Plant height
Chickpea	E-153	0.88	1.39	1.63	1.19
	ICCL4320	0.96	1.12	1.22	1.10
Lentil	L-5	1.00	1.50	1.47	1.00
	84143	0.93	1.56	1.25	0.97
Cowpea	HAF-16	1.20	1.16	1.01	1.07
	HAF-43	0.89	1.17	1.05	1.00

Table 2. Ratio of growth parameters of autumn-to spring-grown plants.

Species	Genotypes	Root elongation rate	Leaf area	Shoot dry weight	Plant height
Chickpea	E-153	0.92	0.35	0.25	0.58
	ICCL4320	0.82	0.36	0.31	0.61
Lentil	L-5	0.88	0.38	0.14	0.44
	84143	0.68	0.44	0.25	0.49
Cowpea	HAF-16	0.56	0.65	0.62	1.00
	HAF-43	0.56	0.59	0.48	1.02

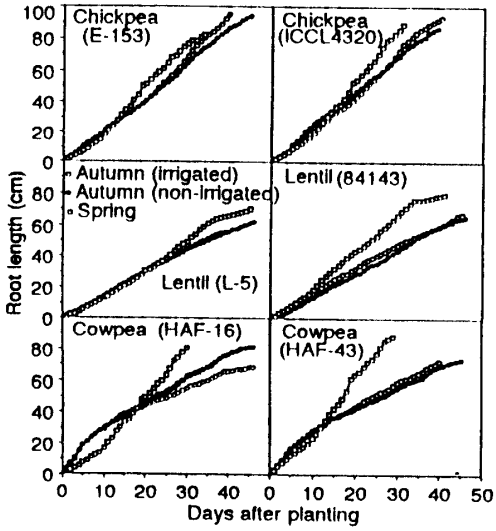

Fig.3. Tap root growth of three food legume species grown in autumn and spring.

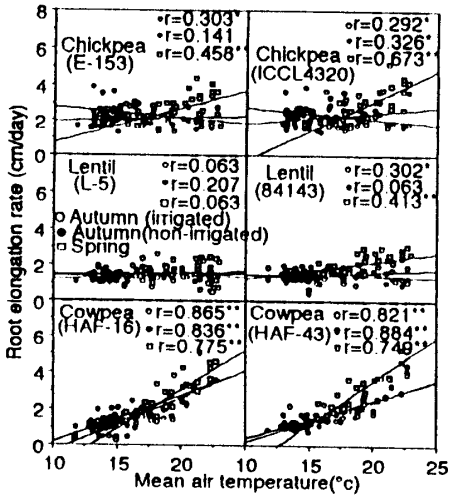

Fig.4. Tap root elongation rate and air temperature relationship of three food legume species.

Reference

1. M. W. Mia, A. Yamauchi and Y. Kono 1993. Jpn. J. Crop. Sci. 62 (extra issue 2) : 209-210.