FACTORS INFLUENCING THE SEED GERMINATION AND GROWTH OF SMALL FABA BEANS (*VICIA FABA* L.)

A Thesis

Submitted to the Faculty

of

Graduate Studies

The University of Manitoba

by

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In Partial Fulfillment of the

Requirements of the Degree

of

Master of Science

Department of Plant Science

Winnipeg, Manitoba, Canada

May 1977

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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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ACKNOWLEDGMENTS

The author wishes to express his gratitude and appreciation to Professor M. Young and Dr. L. E. Evans for helpful direction and encouragement throughout the study. Their guidance and suggestions in the preparation of the project are also acknowledged.

Thanks are also due to Professor A. Ridley, Dr. M. W. Oggema and Dr. M. O. Osoro for their criticisms and suggestions during the preparation of this manuscript.

Gratitude is also expressed to members of staff of the National Plant Breeding Station, Njoro, Kenya who contributed invaluably in setting and conducting field studies at Njoro, Kenya.

The work reported herein was undertaken by the author during the tenure of a Canadian International Development Agency Scholarship. Leave of absence was granted by the Ministry of Agriculture, Kenya during the tenure of the scholarship.

ABSTRACT

Mulamula, Hosea Hunter Alusiola, M.Sc. The University of Manitoba, May, 1977. Factors Influencing the Seed Germination and Growth of Small Faba Bean *Vicia faba* L. Major Professor: G. Morley Young.

Factors associated with seed germination and growth of small faba bean *Vicia faba* L. were examined. The water imbibition rate, seed treatment on pre-germination seed, several levels of growth temperature and the germination emergence of different seed types were studied. In addition, the effect of sowing depth on rate of emergence; and the relationship between yield and plant characters of twenty small faba bean cultivars grown under field conditions at Njoro, Kenya was determined.

Water absorption rate was affected by a number of factors. These included: the initial seed moisture potential, temperature and the moisture potential of the culture medium. Seed scarification had no effect on seed water imbibition rate.

The process of germination was sensitive to the temperature of the culture media. Low temperatures reduced the rate of germination while high temperatures increased it. Seed scarification had no effect on rate of germination, but reduced the total germinability.

The rate of emergence of small faba bean was affected by depth of sowing, high temperatures and seed scarification. Shallow sowing, high temperatures close to 20^{o}C and scarification increased the rate of emergence.

There were significant differences in yield, plant characters and disease reaction among the twenty cultivars of small faba bean grown under field conditions at Njoro, Kenya. Cultivars Ackerperle, Diana, and Klein Thuringer were among the best in yield while cultivars Fribo, Primus and Primerperle were the poorest. The three plant characters highly correlated with yield were pods/tiller, seeds/tiller and tillers/plant. The correlation was significant ($P < 0.05$). The highest correlation ($r_{ij} = 0.8715$) between any two plant characters was observed between pods/tiller and seeds/tiller. The two best plant characters describing yield were pods/tiller and tiller/plant. They accounted for about 44% of the variation observed in yield.

Three major fungal diseases namely: chocolate spot disease (*Botrytis fabae*), Sclerotina wilt, and bean rust (*Uromyces fabae*) were - in field observation plots at Njoro, Kenya. In addition, an unknown virus disease was observed on some of the cultivars studied. Cultivar Klein Thuringer showed some tolerance to the disease. The main insect pests identified were aphids (*Aphis fabae*) and cutworms (*Agrotis lungidentifera* and/or *Agrotis segetum*).

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INTRODUCTION

The prevalence of low standards of nutrition in developing countries is probably one of the major factors responsible for the disparity in development that exists between developing and developed countries. One pulse crop, high in protein and yield potential which has come under intensive investigation as a possible source of protein in developing countries is small faba bean, *Vicia faba* L.

In the last thirty years (Anonymous, 1970), there has been a major reduction in starch and an increase in per capita protein consumption in developed countries. A similar change in this direction is lacking in developing countries. In 1966-1967, the per capita beef and milk production in North America was 80 and 500 kg, respectively. The per capita beef and milk productivity for developing countries during the same period was 10 and 70 kg, respectively. A projected increase in demand for animal protein during the 1970 to 1980 decade was forecast by Anonymous (1970). In response to this projected demand, several measures aimed at promoting the production of high quality animal and vegetable protein were made. They included efforts to raise the level and quality of protein in cereals commonly accepted in many diets by suitable agronomic practices; expansion of the productivity of grains high in protein or oil and an increase in animal products.

Kenya, with a population of 12.9 million and an annual birth rate of 3.5% (Kenya five year development plan, 1974 to 1978) advanced several measures in response to recommendations made by Anonymous (1970). They included an increase in milk and beef production from 270 million litres and 183,000 tons in 1974 to 400 million litres and 235,000 tons, respectively in 1978. In addition, the Government of Kenya planned to spend K£ 134,000 on the development and expansion of pulses as an important source of cheap protein for domestic and export markets between 1974 and 1978. It is evident, therefore, that developing countries have recognized the need for improving food quality and quantity and are prepared to look at new crops and methods of production to meet this requirement. One of the crops that has recently attracted the interest of researchers is small faba bean, *Vicia faba* L.

Small faba bean, *Vicia faba* L., is a legume and a member of the vetch family. According to Morgan (1970), small faba bean was cultivated by the Greeks, Romans and North American Indians as early as the year 5000 B.C. Possible centres of origin (Morgan, 1970) are in the neighbourhood of the Southern Caspian sea and the maritime regions of the North extending as far as south of Sudan (latitude 20°N) in Africa and as far north as Scandinavia. Its cultivation is mainly concentrated in areas around the Middle East, Asia Minor and Sudan (Cobley, 1957) where it still constitutes a major source of protein in human diet.

The earliest account on cultivation of small faba beans in Kenya dates back to 1929. Watt (1929) tested small faba beans along with other crops for its potential as a source of green manure, shelter belt, and a cover crop. He recorded some success and recommended it to areas above 1700 metres above sea level (a.s.l.). A potential yield of 10 tons/ha of green manure was recorded after 3 to 4½ months of growth. Poor nodulation was observed in the report. The report however, did not state whether the beans used were inoculated or not. Lathbury (1932), carried out yield trials with small faba beans at Njoro and Kitale Plant Breeding Stations. Seed yields of 6.5 and 9.8 q/ha were recorded at Njoro and Kitale, respectively. Excellent vegetative growth was recorded at Kitale where plant heights of two metres were recorded.

Benstead (1934), Wolfe (1934), Maher (1934) and Anonymous (1933) expanded small faba beans projects to include experimental sites at Molo (2800 metres a.s.l.) and Rongai (1900 metres a.s.l.). Four Egyptian cultivars, namely Rebaya 7, 8, 19 and 23 were included in the tests. All the workers recorded failure in the areas tested. They reported little or no nodulation on the plants. Maher (1934) attributed failure of the test in Kitale to excessively wet conditions followed by drought and weeds. Leckie (1934) tested cultivars Chitoori, Coimbatore, Maduka, Kistna and Cuddapan in several locations in the Central Province of Kenya. Yields recorded by the authors were low, averaging 100 kg/ha. At many locations no yield was recorded on account of severe drought during the period of experimentation. Ball (1934) retested cultivars Rebaya 7, 8, 19 and 23 at Molo, Rongai, and Njoro, and unlike earlier workers suggested that investigations on small faba beans be continued to test its role as a source of livestock protein and not as a source of green manure.

Although small faba bean was a major source of protein in human food and livestock feed in the past in Europe, it progressively fell in disfavour owing to the influx of cheap high quality oil/protein plant material from developing countries, and the yield instability prevalent in small faba beans (Anonymous, 1972; Leckie, 1934; Soper, 1953).

Maher (1934), Soper (1934) and Morgan (1970) attributed yield instability to the erratic nature of germination and emergence which resulted in poor stands and lack of competition against weeds. The authors also attributed yield instability in faba bean to high incidences of pests and diseases.

Most of the work on small faba bean reported by workers from Kenya including Watt (1929), Anonymous (1933, 1934), Benstead (1934) and Wolfe (1934) aimed at assessing the potential of small faba bean as a source of green manure. There is little or no information on the potential of small faba bean as a source of protein for livestock on the lines suggested by Lathbury (1931), Leckie (1934), Ball (1934) and Anonymous (1972).

The aims of the present investigations were:

1. To determine factors influencing the rate of germination and emergence in small faba beans.

2. To observe the general performance of twenty established small faba bean cultivars grown under field conditions at Njoro, Kenya, with respect to:

(a) Diseases and pests.

(b) Yield potential, and the relationship between yield and plant characters.

(c) Assessment of the feed value by analytical procedures of small faba beans grown at Njoro, Kenya.

2. REVIEW OF LITERATURE

2:1 Factors Affecting Germination and Emergence of Small Faba Bean

The process of germination and emergence of seeds is normally preceeded by a two-phase moisture uptake process. This was identified by Esashi and Leopold (1968) as the initial passive water absorption phase, followed by the active water absorption phase. As seed moisture content increased to within the critical moisture level required by the seed, embryo growth initiated, resulting in visible germination and emergence. Stiles (1948) found that the critical moisture content for small faba bean was 55%. Below this, embryo growth, germination and emergence were inhibited. It is evident therefore, that factors controlling pre-germination water absorption rate will ultimately affect the subsequent rate of germination and emergence in seeds. Such factors may be intrinsic and/or extrinsic to the seed.

2:1:1 Intrinsic Factors Affecting Water Absorption by Seed

Barton (1965B) and Lang (1965) stated that many agricultural and ornamental seeds remained in a resting condition as long as they were in dry storage. When suitably moist medium, favourable temperature and aeration were provided, seeds germinated immediately. They found however that in some seed types, the embryo was in a genuine endogenous dormant condition and would not germinate even when favourable conditions were provided. Barton (1965B) noted that many seeds of *Leguminosae* (to which small faba bean belongs) possess hard seed coats which inhibited germination and/or emergence under unfavourable conditions by remaining impermeable to water and/or gaseous exchange. He reported that in some members of *Leguminosae* the seed coat imposed a mechanical restriction to embryo development. Barton (1965B) stated that there was great variation in the percentage of hard seeds between species, within a population of seeds of the same species, and from one season to another. Since small faba bean flowers continuously, a variation in physiologic age amongst seeds of the same plant is expected. It is also expected that adverse conditions during growth will have differential effect on seeds of the same plant, probably resulting in differences in rate of water absorption. He attributed seed-coat impermeability common in legumes to the presence of a thick cuticle of the seed coat and suggested that under field conditions many impermeable leguminous seeds were made permeable by weathering effect and microbial activity on the seed coat.

Barton (1965B) stated that pre-soaking seeds of *Caesalpinoides* reduced the initial period of water absorption before germination, but pre-soaking seeds of *Papilionoides* to which small faba bean belongs had no effect on rate of water absorption. This suggested that the probable adverse effect of the seed coat on germination and emergence was via some function other than impermeability to water absorption *per se*. Hinton (1955), studying the resistance of testa to water movement in wheat kernels found that resistance to water absorption was influenced by the endosperm and not the testa.