

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

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## 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°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*), Sclerotinia 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*).

## TABLE OF CONTENTS

	PAGE
ABSTRACT .....	iii
1. INTRODUCTION .....	1
2. REVIEW OF LITERATURE .....	5
2:1 Factors Affecting the Germination and Emergence of Small Faba Bean .....	5
2:1:1 Intrinsic Factors Affecting Water Absorp- tion by Seed .....	5
2:1:2 Pseudo-Intrinsic Factors Affecting Germina- tion and Emergence .....	7
2:1:3 Effect of Seed Isotypes .....	8
2:1:4 Storage Conditions .....	9
2:2 Extrinsic Factors Affecting Rate of Germination and Emergence .....	10
2:2:1 Effect of Soil Temperature .....	10
2:2:2 Effect of Soil Solution and Moisture Status on Germination and Emergence .....	12
2:2:3 Effect of Soil Physical Properties .....	13
2:3 Effect of Seed Treatment on Rate of Germination and Emergence .....	14
2:3:1 Effect of Seed Stratification .....	15
2:4 Agronomic Aspects of Small Faba Bean .....	16
2:4:1 Fertilization and Seeding Practices .....	16
2:4:2 Diseases and Pests of Faba Bean .....	17
2:4:3 Past Yield Records in Small Faba Bean .....	19
2:4:4 A Study of Relationship Between Yield and Plant Characters in Small Faba Bean .....	19
2:5 Utilization of Small Faba Bean .....	19
3. MATERIALS AND METHODS .....	23
3:1 Water Absorption, Germination and Emergence Studies .....	23
3:1:1 Test Media, Seed Samples and Incubation Conditions .....	23

## TABLE OF CONTENTS - Continued

	PAGE
3:1:2 Estimation of Moisture Content of Sand at Field Capacity .....	24
3:1:3 Seed Moisture, Germination and Emergence Determination .....	27
3:2 Isolation of Faba Bean Isotypes .....	28
4. EXPERIMENTAL PROCEDURE FOR INDIVIDUAL EXPERIMENTS .....	32
4:1:1 Water Absorption Studies .....	32
4:1:2 Germination Studies .....	33
4:2 Effect of Seed Stratification on Rate of Germination and Emergence .....	33
4:2:1 Cold Temperature Treatment .....	34
4:2:2 Effect of Temperature Fluctuation on Rate of Emergence .....	35
4:3 Studies on Two Faba Bean Isotypes .....	36
4:3:1 Water Absorption Studies .....	36
4:3:2 Effect of Water Absorption and Seed Scarification on Seed Volume of Eight Small Faba Bean Isotypes .....	37
4:3:3 Effect of Scarification on Emergence Rate of Some Small Faba Bean Isotypes .....	37
4:4 Effect of Sowing Depth and Seed Size on the Rate of Emergence in Small Faba Bean .....	38
4:5 Field Observation Studies .....	40
4:6 Yield and Plant Character Studies .....	42
5. RESULTS AND DISCUSSIONS .....	46
5:1 Water Absorption Studies .....	46
5:2 Germination and Emergence Studies .....	51
5:2:1 Germination Studies .....	51
5:2:2 Emergence Studies .....	54
5:3 Seed Stratification Studies .....	59
5:4 Studies on Faba Bean Isotypes .....	63
5:5 The Effect of Sowing Depth and Seed Size on Rate of Emergence in Small Faba Bean .....	71
5:6 Field Observation Studies at Njoro, Kenya .....	76
5:6:1 Meteorological and Soil Analysis Data .....	76

## TABLE OF CONTENTS - Continued

	PAGE
5:6:2 Field Crop Establishment and Growth .....	76
5:6:3 Insect Pests and Diseases .....	78
5:7 Yield and Plant Character Studies .....	85
5:7:1 Yield Potential Assessment .....	85
5:7:2 Relationship Between Yield and Single Plant Character .....	89
5:7:3 Relationship Between Yield and Two Plant Characters .....	91
5:7:4 Relationship Between Yield and Three or More Plant Characters .....	91
5:7:5 Correlation Between Yield and Plant Characters of Twenty Faba Bean Cultivars .....	94
5:7:6 Path-Coefficient Analysis of Correlation Between Yield and Plant Characters .....	96
5:8 Feed Potential of Faba Bean Grown at Njoro, Kenya .....	102
6. CONCLUSION .....	105
7. LITERATURE CITED .....	112



## LIST OF TABLES

TABLE		PAGE
3:2	Isolates of Faba Bean Isotypes .....	31
4:2:1	Treatments Used in Seed Stratification Studies .....	34
4:2:2	Treatment Used in Studies on the Effect on Initial Seed Moisture Content and Temperature Fluctuation on Rate of Emerg- ence of Small Faba Bean.....	36
4:4	Treatments Used to Study the Effect of Seed Size and Sowing Depth on Small Faba Bean Emergence.....	39
5:1a	Effect of Temperature and Seed Scarification on Water Absorption Rate of Faba Bean Cultured in Water.....	46
5:1b	Effect of Temperature and Seed Scarification on Water Absorption Rate of Small Faba Bean Cultured in Sand.....	48
5:1c	Effect of Culture Media and Temperature on Water Absorption Rate in Small Faba Bean.....	49
5:2:1a	Effect of Temperature and Seed Scarification on Rate of Germination of Small Faba Bean Cultured in Sand.....	52
5:2:1b	Effect of Temperature and Seed Scarification on Rate of Germination of Small Faba Bean Cultivated in Water .....	53
5:2:2a	Effect of Temperature and Seed Scarification on Rate of Emergence of Small Faba Bean Cultured in Sand .....	55
5:2:2b	Time Distribution of Water Absorption, Germina- tion and Emergence in Small Faba Bean Cultured in Sand at 20°C .....	58
5:3:1	The Effect of Low Temperature Treatment on Rate of Germination and Emergence in Small Faba Bean Cultured at 20°C Germination and Emergence as a Function of Time .....	60

## LIST OF TABLES - Continued

TABLE	PAGE
5:3:2      The Effect of Temperature Fluctuation on Rate of Emergence of Imbibed and Unimbibed Small Faba Bean Cultured in Sand at 20°C .....	61
5:4:1      Effect of Water Absorption on Seed Volume of Eight Small Faba Bean Isotypes Cultured in Water at 20°C .....	64
5:4:2      Water Absorption Rate in Two Small Faba Bean Isotypes Cultured in Water at 20°C .....	65
5:4:3      Effect of Seed Scarification on Rate of Emergence of Some Small Faba Bean Isotypes Cultured in Sand at 20°C .....	69
5:5         The Effect of Sowing Depth and Seed Size on the Rate of Emergence in Small Faba Bean .....	72
5:6:1      Meteorological and Soil Analysis Data Njoro, Kenya .....	77
5:6:3      Disease Score of Twenty Faba Bean Cultivars Grown at Njoro, Kenya .....	79
5:7         Analysis of Variance of Plant Characters .....	86
5:7:1      Yield and Plant Characters of Twenty Small Faba Bean Cultivars .....	87
5:7:3      Regression of Yield on Two Plant Characters .....	92
5:7:4      Regression of Yield on Three Plant Characters .....	93
5:7:5      Correlation Between Yield and Plant Characters of Twenty Small Faba Bean Cultivars .....	94
5:7:6      The Path-Coefficient Analysis Showing the Direct and Indirect Effects of Plant Characters on Yield in a Population of Twenty Small Faba Bean Cultivars .....	98
5:8         Feed Potential of Small Faba Beans Grown at Njoro, Kenya .....	103

## LIST OF FIGURES

FIGURE		PAGE
3:1:1a	Lot "A" normal seed, lot "B" diseased seed .....	25
3:1:1b	Seed grades: small (S), medium (M) and large seed (L) .....	26
3:2	Isolation diagram of small faba bean isotypes .....	30
4:6	Path-coefficient diagrams for two characters and their influence on yield .....	45
5:2:2a	Effect of seed scarification on rate of emergence on day five in small faba bean cultured in sand at 20°C .....	56
5:4:1	Water absorption rate as a function of time in two small faba bean isotypes .....	66
5:5	Percent emergence as a function of sowing depth .....	73
5:6:3a	Sclerotina wilt on small faba bean .....	80
5:6:3b	Sclerotina wilt on faba bean .....	81
5:6:3c	Leaf spot diseases caused by chocolate spot disease and bean rust .....	83
5:7:2	Regression lines of yield as a function of $X_1$ (pods per tiller); $X_2$ (seeds per tiller) and $X_5$ (tillers per plant) .....	90

## 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 preceded 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.