INFLUENCE OF VIGOUR LEVELS ON EMERGENCE, GROWTH AND YIELD PERFORMANCE OF FRENCH BEAN Cv. ARKA KOMAL (*Phaseolus vulgaris* L.)

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DEDICATED TO
MY BELOVED GRAND MOTHER
KESTURAMMA

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C E R T I F I C A T E

This is to certify that the thesis entitled **'INFLUENCE OF VIGOUR LEVELS ON FIELD EMERGENCE, GROWTH AND YIELD PERFORMANCE OF FRENCH BEAN Cv. ARKA KOMAL (Phaseolus vulgaris L.)** submitted by **Mr. T.C.DEVARAJU** for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **SEED TECHNOLOGY** of the University of Agricultural Sciences, Bangalore is a record of research work done by him during the period of study in this University under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

BANGALORE
~~September~~ 3.1.1997

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(T.C. DEVARAJU)

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CHAPTER - I

INTRODUCTION

I. INTRODUCTION

French bean (*Phaseolus vulgaris* L.) is the most popular vegetable crop grown for its tender pods and also for dry pulse seed, it is a rich source of protein (22%) and carbohydrate (57%) besides it contains phosphorus, calcium and vitamins. It is native to the new world, probably central Mexico and Gautemala and it is widely cultivated in tropics, sub tropics and temperate regions.

In the World, French bean is grown in an area of 245.76 lakh hectares with a production of 161.33 lakh metric tonnes and productivity of 656 kg/ha (Anon.,1992). In India the crop is grown in an area of 89.00 lakh hectares with production of 37.00 lakh metric tonnes and productivity of 416 kg/ha.

Seed is one of the basic and living inputs in crop production. The major problem in french bean production is the rapid loss of seed vigour and viability during storage. The farmer always looks for seeds of good quality with high seed germination and seedling vigour for better establishment and higher yields. The seedsmen also are keen about longevity of the seed from the point of saleability, which otherwise become unsaleable incurring heavy losses.

To obtain uniform emergence, growth, establishment and maximum seed yield, seed vigour is an important seed quality factor which must be taken into account. Even with

the good germination the yield may be reduced if seedling vigour is low.

Seed vigour is influenced by various factors like size, colour, variety, mechanical damage, pathogens, faulty harvesting, processing, transportation and storage conditions. Differences in vigour as affected by various factors are often not detected in the ordinary germination test. Therefore, the need for specific vigour tests and their application is very essential to determine the vigour of french bean seeds and to correlate the results of these vigour tests to field stand potential.

Seed vigour is a highly complex, phenomenon involving synthesis of energy yielding and metabolic compounds at biochemical levels, speed and totality of germination, mechanical rupture, tolerance of seeds to environmental stress etc.

Vigour tests have much more scope as they provide additional information on seed quality and help in predicting the storability as well as the quick disposal of weak seed lots, since the seed lots having higher initial seed vigour will have better storability. Further, the seed producer or dealer could also suggest the farmer to adjust the seed rates, looking into the actual vigour of seed in order to maintain the uniform and optimum field stand.

Seed vigour studies on other crops such as radish knol-khol, carrot and garden bean revealed that the seed vigour has influence on the crop performance and yield (Karuna and Aswathaiah,1989). Seed may have good germination but low vigour may reduce field stand cause poor growth resulting in low yield. Therefore, more studies are needed to generate enough data and information based on which reliable recommendations can be made to seed producers as well as seed traders. Hence, the present investigation entitled "Influence of Seed Vigour Levels on Emergence, Growth and Yield Performance of French Bean (Phaseolus vulgaris L.) cultivar Arka komal" was undertaken with the following objectives.

1. To study the effect of seed vigour levels on per cent germination and other vigour indices.

2. To study the effect of seed vigour levels on field performance and seed yield, and

3. To study the effect of seed vigour levels on seed quality parameters.

CHAPTER - II

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Seed vigour is the most important factor used to determine the seed quality. The information pertaining to various aspects of seed vigour in french bean is very little. As such the reviews relating to laboratory and field performance of other related crops have been included along with the available reviews on French bean (Phaseolus vulgaris L.).

2.1 CONCEPT OF SEED VIGOUR

The term seed vigour generally refers to positive aspects of seed quality. The concept of seed vigour has been extensively reviewed by many scientists. Isley (1957) defined seed vigour as the "sum total of all seed attributes which favour the stand establishment under unfavourable field conditions".

Delouche and Caldwell (1960) defined seed vigour as the sum total of all seed attributes which favour rapid and uniform stand establishment in the field.

Heydecker (1972) suggested that vigour is scientifically a vague term which when applied to seed denotes that they are likely to perform well in the field.

Perry (1972) proposed that seed vigour, is a physiological property determined by the genotype and modified by the environment, which governs the ability of a

seed to produce a seedling rapidly in the soil and the extent to which that seed tolerates a range of environmental factors.

Ching (1973) contended that seed vigour is a complex phenomenon which involves many endogenous biochemical factors and numerous exogenous factors. According to Grabe (1973) the term seed vigour generally refers to positive aspects of seed quality. Butler (1978) defined seedling vigour as seeds exhibiting rapid uniform germination and a satisfactory performance over a wide range of adverse field conditions.

While opinions continued to vary among seed scientists as what components or factors should be considered in vigour concepts, the Association of Official Seed Analysts (AOSA) and the International Seed Testing Association (ISTA) set up a committee to work into the problem of seed vigour and recommend broad based or comprehensive concepts and definitions which could take into account all the critical factors involved. Total of all those properties in seed which, upon planting result in rapid and uniform production of healthy seedlings under a wide range of environmental conditions including favourable as well as stress conditions. This definition was recently adopted as the official AOSA definition with minor modifications (Anon., 1983). The ISTA definition is similar and states that seed vigour is the "sum of those properties

which determine the potential level of activity and performance of seed or seed lot during germination and seedling emergence" (Anon., 1985).

Bergsten and Simak (1985) defined seed vigour as the potential of seed for rapid, uniform emergence and develop in normal seedlings.

2.2 GENETIC AND MORPHOLOGICAL ASPECTS OF SEED VIGOUR

Dickson (1980) pointed out that very few seed quality characters including seed vigour have been studied genetically and have been found to be polygenic in inheritance. He strongly recommended that plant breeders should study the genetics of seed quality, because of its close relation to the quality of the produce.

Ramamoorthy et al. (1989) opined that, the seed vigour, viability and storability are important factors in addition to higher yield in any breeding programme and genetic vigour may also include the ability of seed to store well.

2.3 BIOCHEMICAL ASPECTS OF SEED VIGOUR

Abdul-Baki (1980) proposed a hypothesis, suggesting three conditions to be met at the biochemical level for maximum expression and maintenance of seed vigour. First, a highly organized organell membrane system to exist in seeds during seed development. Second, disorganization of organelles of membrane system during seed maturation, and

dehydration to proceed in an orderly manner such that its reorganisation becomes possible in the shortest possible time, upon rehydration, all membranes become fully reorganised before the cells become fully hydrated.

Mitochandria is the most studied cellular organelle with regard to seed vigour. Abu-Shakra and Ching (1967) indicated that decrease in mitochandrial phosphorelative efficiency in old seeds as a major reason for loss of vigour.

Perl et al. (1978) postulated that increase in activity of proteinase results in the suppression of all other enzyme activities related to seed vigour.

Chauhan et al. (1984) investigated the major changes in sub-cellular system (i.e., membranes, mitochandria, Ribosomes and DNA) and enzyme machinery which lead to loss of viability and vigour.

Ageing mechanism in seeds resulting from lipid peroxidation accompanied with biomembrane degradation, protein denaturation, interference with DNA and protein synthesis, accumulation of toxic materials and the destruction of the electron transport system of oxidative phosphorelation (Wilson and McDonald, 1986).

Basavarajappa et al. (1991) investigated the changes occurring during accelerated ageing of maize seeds and reported that decrease in the level of phospholipids and ascorbate and in the activity of peroxidase and increase in the activity of phospholipase-A. The level of total free fatty acids and molonaldehyde along with the formation of conjugated lipids like Trienes and tetraenes all indicated probable integral membrane peroxidation in seeds. reduction in the total content of food reserve like CH reducing sugar and protein was found in aged seeds. decreased activity of the enzyme acid phosphatas phosphomonoesterase and dehydrogenase was noticed duri.. accelerated ageing. A substantial increase in total free amino acids and in the activity of Amylase and protease, confirm the degradation of stored food in the seed during ageing.

2.4 EVALUATION OF SEED VIGOUR IN THE LABORATORY

Although germination tests have long been established as standard means for evaluating seed quality, significant progress in standardization of methods to evaluate seed vigour has been made recently.

2.4.1 Standard germination test

Morphologically, germination is the transformation of an embryo into a seedling physiologically, germination involves the acceleration of metabolism and the resumption of active growth of the embryonic axis. The AOSA rules for

testing seeds (Anon., 1978) defined germination as the emergence and development of essential structures from the embryo of the seed in question which are indicative of the activity of producing a normal plant under favourable conditions.

Heydecker (1969) has also contended that it is rather meaningless to base an estimate of the quality of a seed lot, wholly on laboratory germination percentage which is the least sensitive index of quality.

Hegarty (1971) worked out the relationship between field establishment and laboratory germination in carrots. According to him germination test conducted at 10 ^{o}C could be more informative than the standard germination test in distinguishing between the potential field emergence of different carrot seed lots. Under certain field conditions, it is possible to use this germination percentage for the more accurate estimation of sowing rates needed to achieve specific plant population.

Grange (1980) stored the bean seeds upto three years at different temperature and relative humidities and found that per cent germinatioin and seedling vigour remained high when seeds were stored at 2 ^{o}C and 30 per cent relative humidity but were significantly low when stored at 22 ^{o}C and 50 per cent relative humidity or 22 ^{o}C and 60 per cent relative humidity.

Durrant et al. (1985) showed a little evidence of agronomically important differences in the relative performance of 20 seed lots of sugar beet with germination rate of 75 to 95 per cent.

Gluchovskij and Saporal (1985) pointed out that emergence rates of sugar beet in the field could be 15 to 33 per cent lower than the laboratory germination results depending on seed properties, soil, climate and farming conditions.

VenkateswaraRao (1990) reported that seed lots of 82 and 70 per cent initial germination exhibited consistantly higher germination, greater speed of germination, higher seedling length and vigour throughout the stage as compared with other seed lots with 67, 52 and 46 per cent initial germination.

2.4.2 Seedling vigour

Seedling vigour is inter-related to various aspects. Such as rate of germination, seedling growth rate, performance in the field, plant growth and yield (Perry, 1976).

2.4.2.1 Vigour index on seedling length basis

Abdulla and Roberts (1969) reported that plants from some seeds with decreased viability exhibited retarded growth of roots and shoots and increase in variability during early growth of barely, broad beans and peas.

2.4.2.2 Vigour index on seedling dry matter basis

Reduction in seedling dry matter production with loss of germinability was reported by Edje and Burris (1971), Pollock and Roos (1972) and Parrish and Leopold (1978) in soybean.

Progressive decline in seedling dry matter with decreased levels of germination was reported by Hussani et al. (1988) in maize. Decline in seedling dry matter with decreased levels of vigour was reported by Karuna and Aswathaiah (1989) in carrot and beetroot.

Ramamoorthy and Karivartharaju (1989) stated that there was no significant and positive correlation between mobilization efficiency and percent germination, indicating that the mobilization efficiency test can be used to assess seed viability at early germination stage in groundnut.

2.5 VIGOUR TESTS

Many tests have been developed and introduced to evaluate the vigour of seed. Isely (1957) classified vigour tests into two groups. The direct test in which field conditions are simulated and in the indirect test certain physiological attributes of seed are evaluated.

Delouche and Caldwell (1960) classified indirect vigour tests into four general groups viz., Biochemical, growth rate, stress and physical measurement tests.

Biochemical tests include the tetrazolium test as a means of evaluating vigour, while growth rate tests include speed of germination, first count, seedling growth rate, other related tests. Stress tests include use of unfavourable temperature and moisture levels, exposed under vacuum, soaking seeds in sodium hydroxide or hot water and use of mechanical barriers such as gravel. They concluded that the exact method of evaluating seed vigour whether direct or indirect is of small sequence as long as good differentiation of vigour difference among seed lots are obtained. This type of test is often difficult to standardise.

According to AOSA seed vigour testing hand book (Anon., 1983), the vigour tests are classified into three broad groups.

1. Seedling growth and evaluation, including seedling vigour classification, seedling growth rate and speed of germination tests.

2. Stress test, includes the accelerated ageing test, cold test, brick gravel/grit and asmotic stress tests.

3. Biochemical tests include tetrazolium (T_Z), conductivity, respiration, glutamic acid decarboxylase activity (GADA) and measurement of adenosine triphosphate (ATP) content. Detailed procedures for conducting the following six most widely used vigour

tests are described in the AOSA seed vigour testing hand book. Accelerated Ageing (AA), SGR, seedling vigour classification, Tz and cold tests. In addition to many of the tests suggested by AOSA, JSTA (perry, 1981) suggested controlled deterioration test and aleurone T_Z test.

2.5.1 Accelerated ageing (AA) test

A stress test first developed by Delouche (1965), the accelerated ageing test is being used widely for evaluating seed vigour as well as predicting storage potential of seed lots. In this test seeds are exposed to 40 to 50 ^{o}C and 90-100 per cent RH. for varying lengths of time depending on the kind of seed, after which a germination test was made. This test is based on the fact that resistance of seeds to the adverse conditions decrease with decrease in vigour levels.

Purkar (1980) demonstrated that the root and shoot growth, per cent field emergence and plant survival of pea and wheat decreased with increase in loss of viability and duration of the accelrated ageing.

Agarwal and Sinha (1980) reported that the okra seeds subjected to AA treatment at 40 ^{o}C and 100 per cent RH for 12 days showed decline in seed germination due to chronological ageing.

Grange (1980) stored the seeds of Phaseolus vulgaris (cv. Contender) for about three years at 2 ^{o}C and 30 per cent

RH, 20°C-22°C and 60 per cent relative humidity. After three years, percentage germination and seedling vigour remained high in 2°C and 30 per cent relative humidity but the viability significantly reduced in seeds kept at 22°C and 60 per cent relative humidity with maximum abnormalities.

Kayzanowski et al. (1982) studied five Phaseolus vulgaris cultivars which were stored at room temperature of 23°C, 35 per cent relative humidity. They observed that accelerated ageing at 42°C and 100 per cent relative humidity gave good evaluation of seed vigour and suggested that 72 hours and 96 hours would be required for seeds stored under ambient conditions.

Maidaj et al. (1982) selected 20 lots of seeds of Phaseolus vulgaris from a number of sites and were artificially aged by keeping them at 100 per cent RH and 42°C for one, two, three and four days. At one day there was a slight reduction in vigour and a rapid fall between third and fourth day. There were significant difference between seed lots at each day.

Seeds of two cultivars of musk melon (cucumis melo) were subjected to accelerated ageing at 45°C and 100 per cent RH for periods upto 28 hrs. They concluded that longer periods of ageing resulted in greater decline in seed quality as measured by laboratory, green house and field emergence (Ednapesis and Timothy, 1983).

Samimy and Taylor (1987) found that deterioration in seed quality of Phaseolus vulgaris during accelerated ageing at 42°C and 100 per cent RH for two days resulted in decline in germination, radicle emergence and reduced hypocotyl length.

Lin (1990) reported that when Phaseolus vulgaris seeds were aged by exposing to 100 per cent RH at 45°C for one to four days. Seed moisture content increased from 10.79 to 22.15 per cent and germination per cent decreased from 88 to 0 per cent after four days ageing.

2.5.2 Speed of germination

Maguire (1962) developed vigour index based on speed of germination as well as germination percentage. It is calculated by summing the number of normal seedling counted each day and dividing by number of days after planting.

2.5.3 TZ viability test

Babare and Kandya (1986) reported that the distribution of red stain was used to classify the seed into ten categories. The viability values were compared with germination test. Results were in agreement with the germination test.

Sung and Chen (1988) while working with rice reported that the seedling growth was positively related to

formazon production, suggesting that the tetrazolium test would be a simple and reliable method of screening for seedling vigour.

2.5.4 Electrical conductivity

Mullet (1979) reported that electrolyte leakage from imbibing seeds is known to have a significant negative correlation with field emergence. The levels of total electrolyte leakage into a leaching solution were measured under various conditions for imbibed seeds of Phaseolus vulgaris, they were differing in germination and other performance characteristics.

Gosh et al. (1980) reported that loss of electroyltes in the imbibing medium increased with ageing, increase of amino acids was observed in aged seeds.

Urbaniak (1984) observed that EC was negatively correlated with germination and field emergence, bud did not give an accurate estimate of seed quality of large seed legumes.

Singh and Khatra (1986) observed increased electrical conductivity in the leachates of the seeds subjected to accelerated ageing. The viability of seeds was negatively correlated with increase in leaching of sugars and amino acids in seed leachates of groundnut.

2.6 SEED VIGOUR ON FIELD PERFORMANCE AND YIELD

Vechi (1970) reported that, there was delay in flowering in plants produced from seeds of low vigour in cowpea.

Pollock and Roos (1972) stated that difference in seed vigour could be manifested instead of, difference in speed of germination, uniformity of emergence and growth rate and yield. In many cases the performance of the seedling after emergence in the field is essentially dependent on the initial seed vigour.

Chen et al. (1972) found that growth and development of radish, squash and turnip plants were significantly affected by seed vigour levels. High vigour seed produced superior plants in all aspects to those from low vigour seed. The medium vigour seed produced plants that were generally intermediate in performance. Stand establishment, growth and development were significantly influenced by physiological condition of the seed.

Camargo and Vaughan (1973) worked with hybrid grain sorghum seed, artificially aged for 0, 3, 5, 7 and 11 days at 42°C and 100 per cent RH to produce five vigour level seeds. Several laboratory and field tests were used to evaluate vigour. They reported that the consequences of low seed vigour were, reduced plant height, delayed panicle exertion and anthesis, less tillering capacity and low

yield. Primary grain yield was reduced by 3, 4, 9 and 14 per cent for the seeds aged 3, 5, 7 and 11 days respectively as compared to the control.

Loss of germination in sorghum by accelerated ageing upto 48 hours caused reduction in yield was observed by Gelmond et al. (1978). Effect of seed size and density grades in groundnut was studied by Godoy et al.(1978),their study revealed that the emergence at 20 days after sowing was highest with high density and lowest with low density groups. But density grades did not have significant affect on yield.

Jones and Gamble (1984) indicated that seed vigour is an important factor determining plant growth in soybean The poor growth of plants produced from low vigour level seed resulted in lower pod production and subsequently lower yield. Similar trends occurred at early growth stages of the crop.

Ogundipe (1984) reported that widely spaced rows of high vigour seedlings grew and developed more rapidly and produced much more grain yield than low vigour seedlings of sorghum.

Adeqbuyi and Burris (1988) reported the influence of seed vigour on seedling emergence, emergence rate, plant height, stem diameter, shoot dry, weight at four and six weeks and ultimate leaf length and width, was high. But as the plants matured the influence of seed vigour decreased.

Although there were both positive and negative relationship among characters influenced by seed vigour, there was no significant influence on grain yield.

Studies on the relationship between various vigour tests with field emergence in cotton seed by Ram et al. (1988) indicated that standard germination and first count germination were most useful tests for the assessment of field emergence potential. Similar studies in chick pea lots by Ram et al. (1989) revealed that standard germination was positively correlated and AA test positively and significantly correlated with seedling emergence. Decline in germination had no significant influence on days to 50 per cent blooming in castor. The control plants (78% germination) reached 50 per cent flowering in 52 days, whereas plants raised with seeds of low germination levels of 55 per cent reached 50 per cent blooming in 53 days (Anon., 1989).

There was a positive association between germination levels and yield components and yield in sorghum hybrids (Venkateshwar Rao, 1990) and in sunflower (Ravinder, 1990).

Yield components like panicle length, 1000 grain weight, number of ear bearing tillers increased with increased levels of germination in paddy (Anon., 1990).

CHAPTER - III

MATERIAL AND METHODS

III. MATERIAL AND METHODS

The laboratory and field experiments were conducted on French bean cultivar Arka komal to study the influence of vigour levels on crop growth, yield and seed quality. Details of the material and techniques followed during the course of investigation are described in this chapter.

The laboratory and field experiments were conducted during 1992-93 at National Seed Project, 'J' Block, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore.

3.1 SEED MATERIAL

Seeds of French bean variety Arka komal produced during April 1991 with 98 per cent initial germination and eight per cent moisture content procured from National Seed Corporation were used for laboratory studies and field experiment.

3.2 TREATMENTS

Six seed vigour levels were created by subjecting the seeds for accelerated ageing at $42^{o}C \pm 2^{o}C$ and 100 per cent relative humidity by keeping the seeds in single layer over a wire mesh for a period ranging from zero to five days. At the end of every 24 hours interval a sample of seeds (500 g) was removed and dried under shade for two days till it attained equilibrium moisture content, i.e., around nine

per cent moisture level. The ageing regime used to obtain six vigour levels are presented with the treatment notations in Table 3.1.

Table 3.1 : Ageing period, seed vigour level and Notations of the treatments used in the study

Treatment Notations	Ageing period (Days)	Vigour level	Germination (%) after Acelerated ageing(AA)
V_0	0	High	97.50
V_1	1	High	94.50
V_2	2	Medium	89.00
V_3	3	Medium	86.50
V_4	4	Low	83.00
V_5	5	Low	78.50

3.2.1 Laboratory studies

1. Standard germination percentage

Germination percentage was determined in the manner prescribed in rules for testing seeds (Anon., 1985). The seeds were germinated in rolled towels in a germinator at 25 $\pm$ 2°C. The germination counts were taken on 5th day and 9th day. The total germination percentage was calculated on the basis of normal seedlings obtained in the first and final count.

2. Shoot and Root length

Ten seedlings from germination test in each replication were randomly selected for the measurement of

root and shoot length in centimeters on the day of final count. The shoot length was measured from collar region to the point of attachment of cotyledons and root length from the collar region to the tip of the primary root.

3. Fresh weight of seedling

Ten randomly selected seedlings in each replication of the germination test on the final count were enclosed in a paper cover and weighed on a top pan balance and the mean weight of seedling expressed in milligrams (mg).

4. Dry weight of seedling

The 10 seedlings selected for seedling length measurement were utilized to determine dry weight of seedling. These seedlings were dried under shade then in hot air oven at 80^{o} C until constant weight was obtained and dry weight per seedling was expressed in milligrams (mg).

5. Vigour index

Vigour Index (VI) was calculated by adopting the formula suggested by Abdul-Baki and Anderson (1973) and Ching (1973).

VI I - Seedling length (cm) x Germination (%)

VI II - Hypocotyl length (cm) x Germination (%)

VI III - Dry weight of seedling (mg) x Germination (%)

6. Mobilization efficiency (%)

Mobilization efficiency was calculated using the formula proposed by Srivastava and Sareen (1974).

$$\text{Mobilization efficiency \%} = \frac{\text{Increase in dry weight of embryonic axis (dry weight of seedling)}}{\text{Decrease in dry weight of two cotyledons}} \times 10$$

Where decrease in dry weight of two cotyledons =
Actual dry weight of seeds in the begining − Dry weight of two cotyledons + Dry weight of seed coat at the end of the experiment

7. Speed of germination

Speed of germination was determined using 50 seeds planted in four replications in rolled towels and germinated at 25°C ± 1°C. Daily counts of germinated seeds (normal seedlings) were recorded upto 9th day. An index of speed of germination was calculated, it is the summation of the number of seeds germinated on specific day divided by reciprocal of a day on which seedlings were counted and removed (Maguire, 1962).

$$\text{Speed of germination} = \frac{\text{No. of seeds germinated on 1st day}}{1} + \frac{\text{No. of seeds germinated on 2nd day}}{2} + \ldots\ldots\ldots + \frac{\text{No. of seeds germinated}}{\text{On final day}}$$

8. Seedling growth rate (SGR)

Seeds were germinated in between paper towel method by placing 25 seeds in each of the three replications, 12

seeds in the first row and 13 seeds in second row, leaving 2.5" from the top and bottom of the towel. The paper towels were rolled loosely with an inner diameter of 2.5 cm and placed at an angle of 45° in plastic container. The container top was covered by polythene sheet to retain the moisture content in the paper towels. The containers were placed in seed germinator at 25 ± 1°C for nine days. The number of normal seedlings were counted and removed. They were later placed in butter paper cover and dried in hot air oven at 80°C till constant weight reached. The total dry weight of normal seedlings was recorded in milligrams and SGR was calculated by using the formula (Anon., 1983).

$$SGR = \frac{\text{Dry weight of normal seedlings (mg)}}{\text{Number of normal seedlings}}$$

9. Electrical conductivity (EC) test

Three replications of five grams seeds each were taken in a beaker and soaked in 25 ml distilled water. Beakers were placed in the incubator at constant temperature at 25° ± 1°C for 24 hours. The EC of the lechates was measured in the digital conductivity meter model (sensitivity conductivity cell CCS-811) and expressed in $\mu mhos/cm^2$.

10. Tetrazolium test

One per cent 2, 3, 5 triphenyl tetrazolium chloride solution was prepared by disolving 10 g of tetrazolium salt

in 1000ml distilled water, the pH of solution was maintained to near neutral by using buffers.

Three replications of 50 seeds each were taken. The seeds were allowed to imbibe moisture over night in between moist rolled towels. Seed coats were removed and placed in one per cent 2, 3, 5 Triphenyl tetrazolium chloride solution for six hours at 25°C ± 1°C in dark place. After the incubation period, the solution was decanted and the seeds were washed in tap water. The seeds were examined for the staining pattern and intensity of staining of essential structures. The viable and non-viable seeds were separated as per the evaluation procedure adopted for soybean by Singh and Dougles (1967).

3.3 FIELD PERFORMANCE STUDIES

The experiment was laid out in randomized complete block design with four replications. The treatment details are furnished below :

V_0 = Seed lot having 97.5 per cent germination without ageing (control)

V_1 = Seed lot having 94.5 per cent germination after one day AA.

V_2 = Seed lot having 89.0 per cent germination after two days AA

V_3 = Seed lot having 86.5 per cent germination after three days AA

V_4 = Seed lot having 83.0 per cent germination after four days AA.

V_5 = Seed lot having 78.5 per cent germination after five days AA.

The seeds were sown in red sandy loam soil after preparing fine seed beds with spacing of 60 cm between the rows and 30 cm between plants. The plot size was 3 m x 3 m, each plot consisted of 5 rows with ten seeds planted in each rows. The fertilizer dosage and other cultural practices were adopted as per the recommendation.

Other details of the experiment

Number of replication	4
Total number of treatments	6
Total number of plots	24
Gross plot size	3 x 3 m
Row spacing	60 cm
Date of sowing	01-07-1992
Date of harvest	24-09-1992

Field observations

1. Field emergence

The seeds were placed at 3 cm deep in furrows opened at 60 cm apart in red sandy loam soil. Seeds were placed at 4 cm apart in the row. Seedlings with a shoot of one centimeter or more above the ground were counted as emerged. The total number of seedlings emerged upto 15th day after sowing were considered and the emergence percentage was calculated. 50 seeds of four replications were used in this study.

2. Plant stand

This observation was recorded by counting all the normal and productive plants surviving in each plot from each treatment at harvest.

3. Plant height

Height of 10 randomly selected plants (excluding border rows) were measured from the base of plant to apical node at harvest and recorded in cms.

4. Dry Matter Production

Dry matter accumulation at harvest was recorded by cutting five randomly selected plants close to the ground, dried in open sun for 24 hrs later in an oven at 80 ^{o}C till the constant weight was reached. The mean dry matter accumulation per plant was expressed in grams.

5. Number of branches per plant

Plants were labelled at random and only main and secondary branches were considered for this purpose and number of branches per plant were recorded.

6. Days to flower initiation and complete flowering

This was done by visual observation in the plots, date of producing Ist flower in ten plants and whole plant population in plot had flowered that day was taken as flower

initiation and complete flowering respectively. The number of days required for complete flowring was recorded.

7. Days to 50 per cent flowering

The number of days taken for flowering in 50 per cent of plant population in the plots from the date of sowing was recorded as days to 50 per cent flowering.

8. Duration of flowering

Duration of flowering was computed by recording the days to initiate flowering and complete flowering.

3.4 YIELD COMPONENT

1. Number of pods per plant

Plants which were selected at randomly and labelled previously ,were used to count the number of pods per plant. Total number of pods in five labelled plants were counted at harvest and average was taken as number of pods per plant. Such observations was recorded from each experimental plot.

2. Number of mature pods per plant

Number of fully matured pods in five labelled plants were counted at harvest and average number of pods per plant was recorded.

3. Number of immature pods

Number of immature pods per plant in five labelled plants were counted at harvest and average number of immature pods per plant were recorded.

4. Pod length

Length of ten pods in each of five plants were measured and mean pod length in each of the plot was recorded and expressed in centimeters.

5. Pod weight per plant

Weight of the pods of five tagged plants was taken and mean pod weight per plant was recorded.

6. Number of seeds per pod

Ten pods from each of the five representative plants taken from the previous studies were threshed and number of seeds per pod was recorded.

7. Number of seeds per plant

Number of seeds in five tagged plants was counted and mean number of seeds per plant was recorded.

8. Test weight

Hundred-seeds taken from the produce of net plot of each treatment in three replications were weighed and expressed in grams.

9. Seed yield per plant

Pods collected from 10 representative plants from each plot were threshed. After threshing the pods, seeds were sun dried and seed weight per plant was recorded in each plot and expressed in grams.

10. Seed yield per plot

Seeds from the net plot of each treatment were weighed and seed yield per plot was recorded and expressed in grams.

11. Seed yield per hectare

Seed yield obtained from net plots were converted on hectare basis and expressed as kg/ha.

3.5 SEED QUALITY STUDIES

Fresh seeds obtained from the field studies of different vigour levels were tested in laboratory by conducting the following tests.

1. Germination (%)
2. Shoot and root length (cm)
3. Vigour index (Germination(%) x Seedling length (cm))
4. Electrical conductivity
5. Seed microflora

Seed Microflora

Detection and identification of storage fungi was done by blotter method as recommended by ISTA (Anon., 1966). Ten seeds were placed equidistantly in glass petridishes of 4" diameter containing three moist blotters. Fourty seeds of each sample (four replications) were used for this test.

The seeds were incubated for eight days at room temperature ($25^{o}C \pm 2^{o}C$) with 12 hours light and 12 hours dark cycles. After incubation the seeds were examined by a low power sterio microscope and fungi infection found on the seeds were recorded.

3.6 STATISTICAL ANALYSIS

The data obtained from the above experiments was analysed using CRD for laboratory and RBD for field studies. The data was analysed accordingly and critical differences were calculated at five per cent level of probability for all the tests and parameters, where F-test was found significant treatment means were compared.

CHAPTER - IV

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

French bean cultivar Arka komal with an initial germination of 98 per cent was subjected for accelerated ageing (for a period of 0 to 5 days) and sub-lots of different vigour levels were created. The results pertaining to the effect of different seed quality parameters in laboratory as well as field emergence, field performance, seed yield and quality are presented in this chapter.

4.1 LABORATORY STUDIES ON SEED QUALITY

The results on different seed quality paramters such as per cent germination, shoot length, root length, fresh and dry weight of seedling, vigour index, speed of germination, seedling growth rate (SGR), electrical conductivity, mobilization efficiency and TZ vigour test were carried out from the seeds of different vigour levels and are presented in Table 4.1 and 4.2.

4.1.1 Germination

Per cent germination differed significantly among different seed vigour levels. Germination percentage declined significantly with decrease in vigour levels from 97.5 per cent in untreated control (V_0) to 78.5 per cent in low vigour level (V_5).

Table 4.1 : Seed germination and other quality parameters as affected by accelerated ageing of French bean Cv.Arka Komal

Treatments	Germination percentage	Shoot length (cm)	Root length (cm)	Fresh weight (mg)	Dry weight (mg)	V Seedling length x germination(%)	V Shoot length x germination(%)	V Dry weight x germination(%)
V_0 Control	97.50	15.47	9.70	823.75	60.25	2393	953	5875
V_1 1 Day AA	94.50	14.70	9.41	801.25	56.25	2278	889	5316
V_2 2 Day AA	89.00	14.31	9.15	774.00	51.00	2029	814	4539
V_3 3 Day AA	86.00	13.63	8.27	683.25	47.50	1914	728	4109
V_4 4 Day AA	83.00	13.50	8.77	653.50	39.50	1884	708	3277
V_5 5 Day AA	78.50	13.40	8.62	626.50	32.50	1742	691	2552
Mean	88.16	14.16	8.98	727.04	47.83	2040	797	4278
SEm±	0.52	0.54	0.20	6.86	0.75	41	16.04	80.96
C.D. at 5%	1.55	NS	0.61	20.69	2.27	123	47.66	243.99

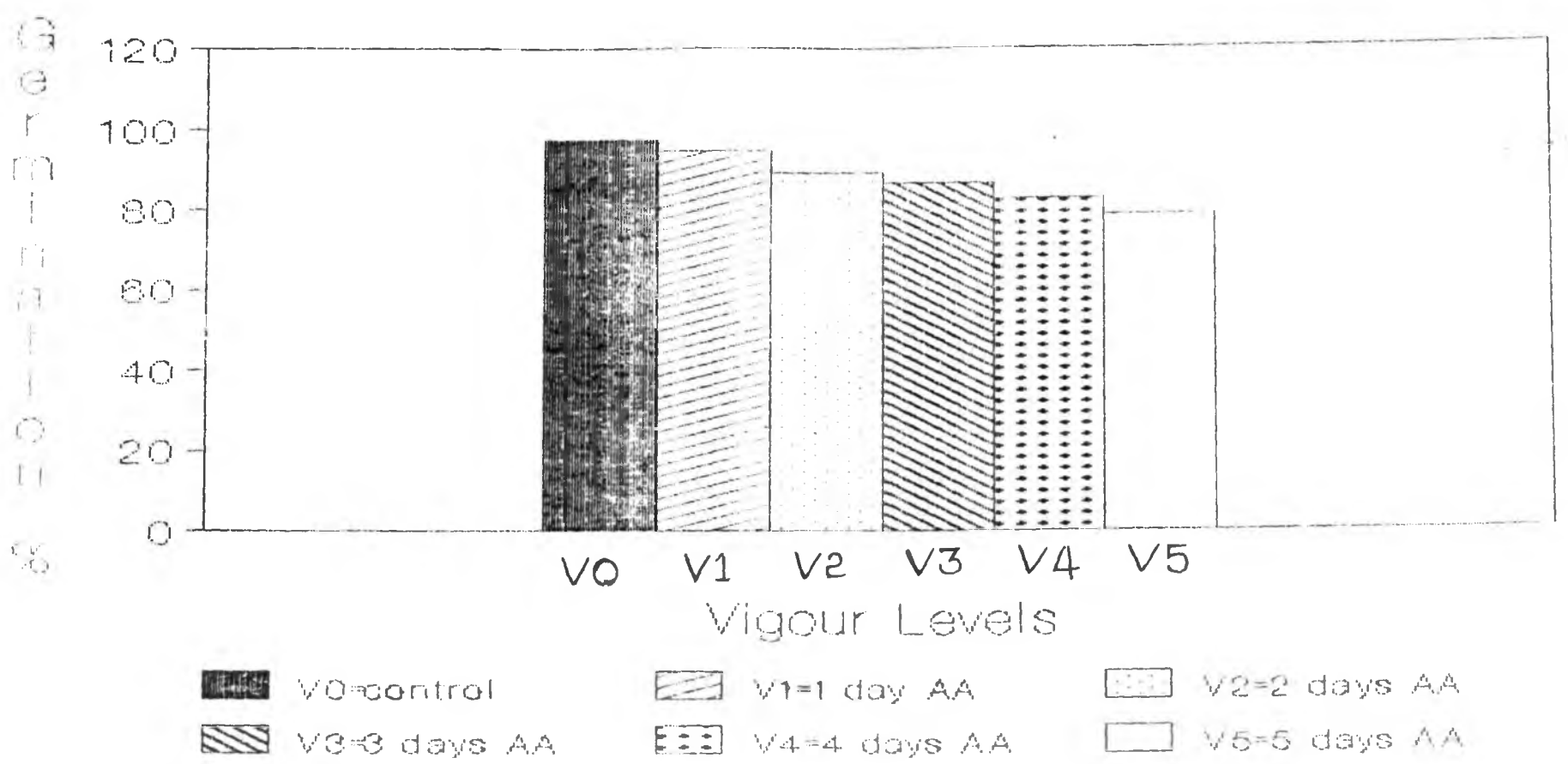

Fig.1:Per cent Germination as influenced by different vigour levels in French bean Cv. Arka Komal

4.1.2 Shoot length

There was no significant difference among the vigour levels w.r.t shoot length.However, a marginal increase in shoot length (15.47 cm) was found in non aged seeds (V_0) as compared to the low (V_5) vigour seeds (13.40 cm).

4.1.3 Root length

Root length differed significantly among the vigour levels. The highest (9.70 cm) root length was recorded in high vigour level seeds (V_0) which was on par with V_1 (9.41 cm). The medium vigour seeds (V_2) recorded (9.15 cm) root length which was on par with V_4 (8.77 cm). The lowest root length (8.27 cm) was recorded in medium vigour seeds (V_3) followed by V_5 (8.62 cm).

4.1.4 Seedling fresh weight

Seedling fresh weight differed significantly among vigour levels. The seedling fresh weight decreased significantly with decreasing vigour levels. Highest seedling fresh weight (823.75 mg) was recorded in high vigour seeds V_0 followed by V_1 (801.25 mg). Whereas, lower seeding fresh weight was recorded in low vigour seeds of V_5 (626.50 mg) followed by V_4 (653.50 mg).

4.1.5 Seedling dry weight

Seedling dry weight significantly declined with decrease in vigour from V_0 to V_5. High vigour seeds V_0

recorded highest (60.25 mg) seedling dry weight and lowest (32.50 mg) was recorded in low vigour seeds V_5.

4.1.6 Vigour index-I

Vigour index calculated on the basis of per cent seed germination and seedling length decreased significantly with decrease in vigour levels. The highest vigour index of 2393 was recorded in V_0 followed by V_1 (2278) which, were on par with each other. Whereas, lowest vigour index was recorded in low vigour seeds V_4 (1884) and V_5 (1742)

4.1.7 Vigour index-II

Vigour index calculated on the basis of per cent seed germination and shoot length, decreased significantly with decrease in vigour levels. Higher vigour index of 953 was recorded in high vigour seeds V_0 which was on par with the vigour levels V_1 (889) and V_2 (814). The lowest (691) vigour index was noticed in low vigour seeds V_5, which was on par with the vigour levels V_4 (708) and V_3 (728).

4.1.8 Vigour index-III

Vigour index calculated on the basis of seedling dry weight differed significantly among the vigour levels. All the vigour levels differed significantly with each other. The highest vigour index (5875) was recorded in high vigour seeds V_0 and lowest in V_5 (2552). Whereas, V_1, V_2, V_3, V_4

Table 4.2: S eed quality paramters as affected by vigour levels of French bean seed Cv. Arka Komal

Treatments	Speed of germination	Seedling growth rate	Electrical conductivity (umhos/cm^2)	TZ test (%)	Mobilization efficiency (%)
V_0 Control	20.55	59.61	949	93.75	60.16
V_1 1 Day AA	19.70	57.12	1051	90.50	57.18
V_2 2 Day AA	19.26	50.40	1179	85.50	49.41
V_3 3 Day AA	18.65	46.12	1202	81.50	47.58
V_4 4 Day AA	17.51	39.31	1225	74.75	45.66
V_5 5 Day AA	17.38	32.60	1246	71.75	44.58
Mean	18.84	47.52	1142	82.87	50.76
SEM±	0.80	1.37	16	0.68	0.92
C.D. at 5%	NS	4.13	48	2.06	2.65

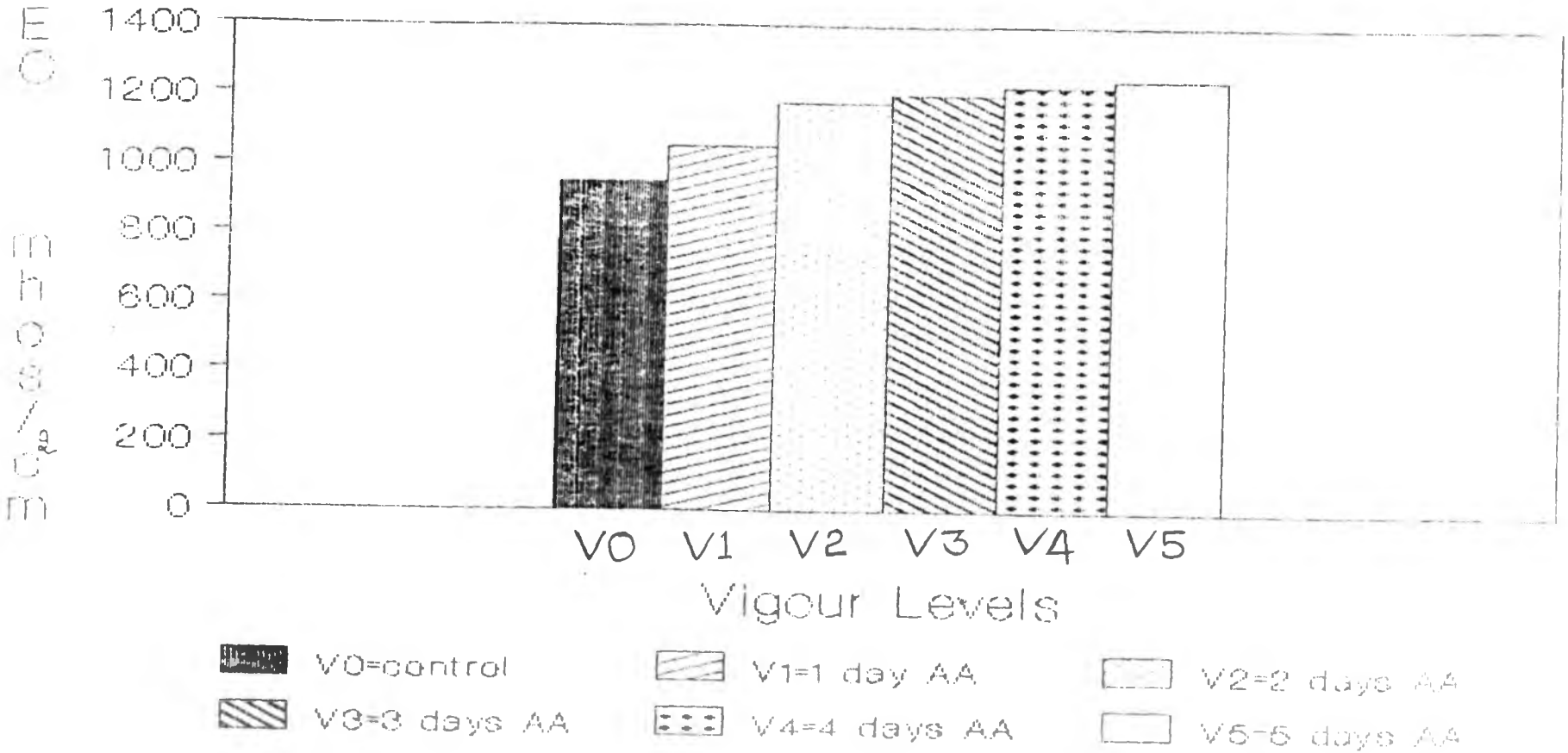

Fig.2:Electrical Conductivity as influenced by different vigour levels in French bean Cv. Arka Komal

recorded vigour index of 5316, 4539, 4109 and 3277 respectively.

4.1.9. Speed of germination

Speed of germinationdid not differ significantly among different vigour levels. However, maximum speed of germination (20.55) was found in control and tended to decrease with increase in the duration of ageing.

4.1.10. Seedling growth rate

The seedling growth rate decreased significantly with decreasing vigour levels. Higher SGR was recorded in high vigour seeds V_0 (59.61) which was on par with V_1 (57.12). Lowest SGR was recorded in low vigour seeds V_5 (32.60).

4.1.11. Electrical conductivity (EC)

Electrical conductivity of different vigour level seeds differed sigificantly with each other. There was considerable increase in EC of seed leachates with decrease in vigour levels. Maximum EC of 1246 umhos/cm^2 was recorded in low vigour seeds V_4 followed by V_5 (1225 u mhos/cm^2) which were on par with V_5 (1202 u mhos/cm^2) and V_4 (1225 u mhos/cm^2. The lowest EC was observed in high vigour seeds V_0 (949 u mhos/cm^2 followed by V_1 (1051 u mhos/cm^2).

4.1.12 TZ vigour (%)

Per cent vigour seeds classified on the basis of tetrazolium test declined significantly with decrease in vigour levels. The high vigour level V_0 recorded high percentage (93.9%) of vigour seeds than any othr vigour levels. The low vigour level V_5 recorded low (71.7%) TZ vigour per cent.

4.1.13 Mobilization Efficiency

Mobilization efficiency differed significantly among the different vigour levels. Mobilization efficiency was high (60.16%) in high vigour seeds V_0 and V_1. The lowest mobilization efficiency was noticed in V_5 (44.58%) low vigour seeds.

4.2 FIELD STUDIES

The data on final plant stand, plant height, number of branches and dry matter production at harvest as influenced by vigour levels are presented in Table 4.3.

4.2.1 Field emergence (%)

Per cent field emergence of different vigour level seeds differed significantly among each other. The maximum field emergence of 91.25 per cent was recorded in high vigour level V_0 followed by 86.25 and 81.50 per cent in V_1 and V_2 respectively. Whereas low vigour seeds V_5 recorded

Table 4.3 : Plant stand /unit area, plant height, number of branchs/plant, and dry matter production/plant as influenced by seed vigour levels in French bean Cv. Arka Komal

Treatmetns	Field emergence (%)	Plant population/ unit area	Plant height (cm)	Dry matter production/ plant (g)	Number of branches
V_0 Control	91.25	43.25	57.25	66.10	3.75
V_1 1 Day AA	86.25	42.25	54.25	62.90	3.00
V_2 2 Day AA	81.50	40.00	52.00	58.07	2.75
V_3 3 Day AA	75.50	37.25	49.00	51.25	2.50
V_4 4 Day AA	68.25	35.50	46.25	46.85	2.25
V_5 5 Day AA	62.00	33.75	45.00	43.17	2.25
Mean	77.45	38.12	50.62	54.72	2.75
SEm±	0.93	0.93	0.71	0.77	0.22
C.D. at 5%	2.82	2.82	2.14	2.32	0.69

lowest (62.0 per cent) field emergence followed by V_4 and V_3 with 68.25 and 75.50 per cent respectively.

4.2.2 Plant stand

Plant stand at harvest differed significantly among the vigour levels. The highest plant population observed was 43.25 in high vigour seeds of V_0 and was on par with V_1 (42.25) followed by V_2 (40.0) and V_3 (37.25) which were on par with each other. The lowest plant population (33.75) was observed in V_5.

4.2.3 Plant height

Plant height recorded at harvest differed significantly among different vigour levels. Significantly higher plant height of 57.25 cm was recorded with high vigour seeds V_0 followed by V_1 (54.25 cm) and medium vigour seeds V_2 (52.00 cm) and V_3 (49.00 cm). The plant height decreased with decrease in the vigour of seed, V_4 (46.2 cm) and V_5 (45 cm) were onpar with each other.

4.2.4 Dry matter production (g)

Dry matter production per plant at harvest differed significantly among the vigour levels. Dry matter production per plant decreased with decrease in vigour levels. Total dry matter production was more in high vigour seed V_0 (66.10 g) followed by V_1 (62.90 g) and V_2 (58.07 g). The dry matter production was lowest in low

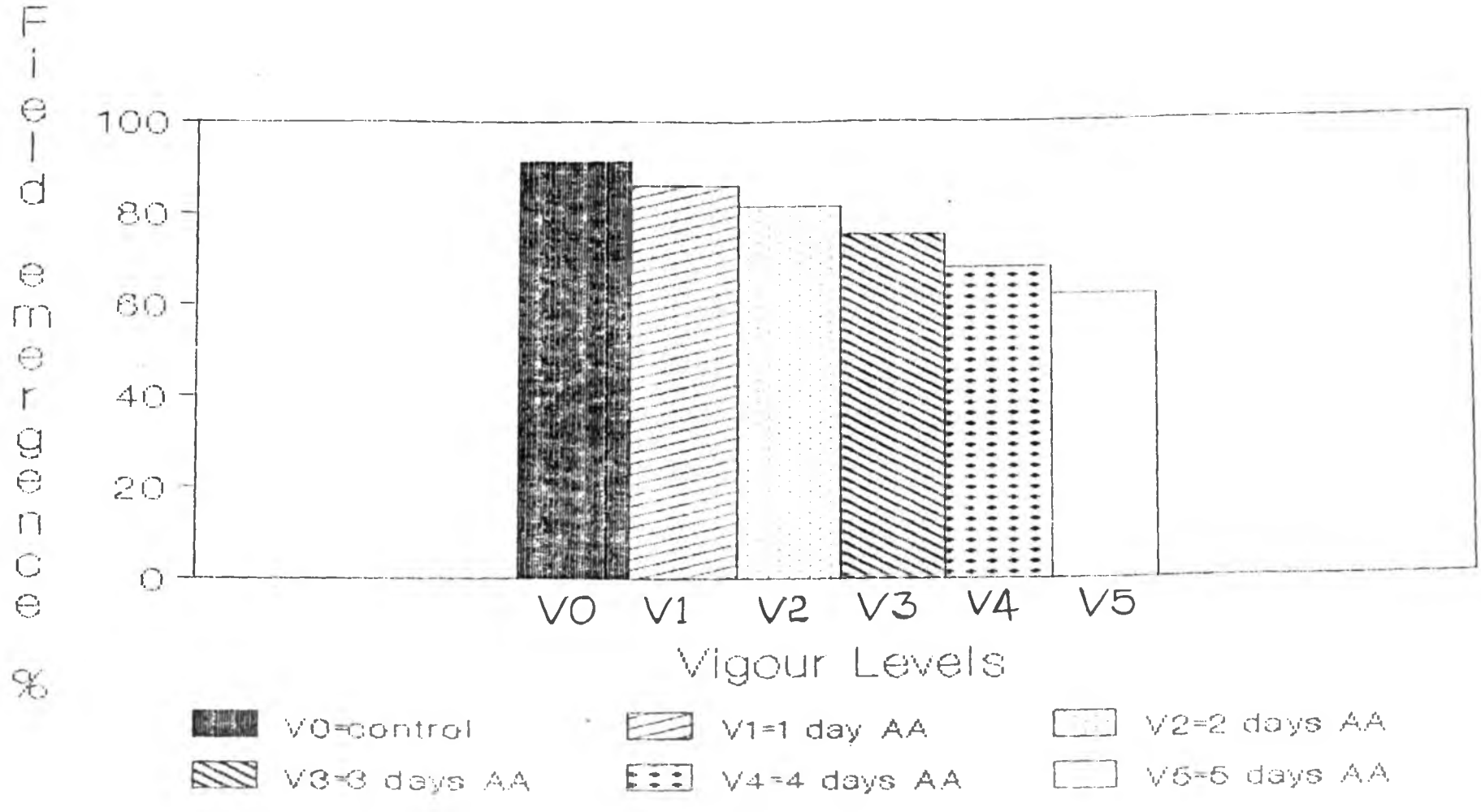

Fig.3:Per cent Field emergence as influenced by different vigour levels in French bean Cv. Arka Komal

vigour seeds V_5 (43.17 g) followed by V_4 (46.8 g) and medium vigour seeds V_3 was recorded 51.25 g of dry matter.

4.2.5 Number of branches

Number of branches differed significantly among the vigour levels. The number of primary branches were 3.75 in high vigour seeds V_0 followed by 3.0 in V_1. The lower number of branches 2.25 were found in low vigour seeds V_5 and V_4.

The data on days taken to initial flowering, days to 50 per cent flowering, days to compelte flowering and duration of flowering period are presented in the Table 4.4

4.2.6 Days taken to flower initiation

Days to flower initiation differed significantly among the vigour levels. The number of days taken to initiate flowering increased from 20.37 to 24.45 days with decrease in vigour levels V_0 to V_5. Early flowering initiation was observed in V_0 with in 20.37 days. V_1 (20.62), V_2 (21.50) which were onpar with (21.50). The initiation of flowering delayed in low vigour seeds V_5 (24.25) by four days and in V_4 by three days (23.0).

4.2.7 Days to 50 per cent flowering

Days to 50 per cent flowering differed significantly among the vigour levels. The number of days taken to 50 per cent flowering ranged from 26.50 to 30.50 days with

Table 4.4: Days to flower initiation, 50 per cent flowering, complete flowering and duration of flowering as influenced by seed vigour levels in French bean Cv. Arka Komal

Treatments	Days to flower initiation	Days to 50% flowering	Days to complete flowering	Duration of flowering period
V_0 Control	20.37	26.50	35.50	16.50
V_1 1 Day AA	20.62	26.75	35.75	16.00
V_2 2 Day AA	21.50	27.50	36.25	15.25
V_3 3 Day AA	22.00	28.00	37.25	15.75
V_4 4 Day AA	23.00	29.75	38.00	15.75
V_5 5 Day AA	24.25	30.50	40.25	16.00
Mean	21.95	28.16	37.16	15.87
SEm±	0.25	0.28	0.30	0.41
C.D. at 5%	0.75	0.85	0.92	NS

decreasing vigour level V_0 to V_5. Early flowering was observed in V_0 (26.55) and V_1 (26.75) days were onpar with each other. Days taken to flowering in V_2 and V_3 were onpar with each other. Flowering was delayed significantly in low vigour seeds of V_4 and V_5 which took 29.75 and 30.50 days respectively.

4.2.8 Days to complete flowering

Days to complete flowering differed significantly among the vigour levels. The number of days taken to complete flowering increased with decrease in vigour level. Number of days taken for complete flowering observed in high vigour seeds of V_0, V_1 and V_2 were 35.5, 35.75 and 36.25 days which were onpar with each other. Whereas the more days taken for complete flowering was noticed in low vigour levels of V_3 and V_4 with 37.25 and 38.0 days which were also onpar with each other. The complete flowering was very much delayed in vigour seeds of V_5 with 40.25 days.

4.2.9 Duration of flowering

The duration of flowering showed non-significant results among the vigour levels. However, the mean flowering period was 15.87 days.

4.3 SEED YIELD AND YIELD COMPONENTS

The data on yield components viz., number of pods per plant, number of matured pods, number of immature pods, pod

length, pod weight, number of seeds per pod, number of seeds per plant, 100 seed weight, seed yield per plant, seed yield per plot and yield per hectare as influenced by the vigour levels are presented in Table 4.5 and 4.6.

4.3.1 Total number of pods per plant

The total number of pods per plant decreased significantly with decrease in vigour levels ranging from 23.50 to 15.50. The highest number of pods (23.50) was found in high vigour seeds (V_0) followed V_1 (21.00), V_2 (19.50) and V_4 (18.00). The lowest number of pods were recorded in low vigour V_4 (16.75) followed by V_5 (15.50).

4.3.2 Number of mature pods per plant

Number of matured pods per plant differed significantly among the vigour levels. Matured pods declined significantly with decrease in vigour levels from 23.0 to 12.75 from V_0 to V_5 respectively.

4.3.3 Number of immature pods per plant

Number of immature pods increased significantly with decrease in vigour levels. The high vigour level seeds V_0 (0.50) and V_1 (0.75) recorded less number of immature pods which were onpar with each other. However, the maximum number of immature pods were found in low vigour seeds V_5 with 2.75 followed by V_4 with 2.00 which were onpar with V_3 with 1.50 pods.

Table 4.5 : Seed yield components as influenced by the vigour levels in French bean Cv. Arka Komal

Treatments	Number of Pods/plant	Number of mature pods/plant	Number of immature pods/plant	Pod length (cm)	Pod weight per plant (g)
V_0 Control	23.50	23.00	0.50	17.35	44.77
V_1 1 Day AA	21.00	20.25	0.75	15.72	41.05
V_2 2 Day AA	19.50	18.50	1.00	15.65	33.40
V_3 3 Day AA	18.00	16.50	1.50	14.40	21.65
V_4 4 Day AA	16.75	14.75	2.00	14.22	20.10
V_5 5 Day AA	15.50	12.75	2.75	13.77	19.00
Mean	19.04	17.62	1.41	15.18	31.07
SEm±	0.34	0.36	0.31	0.42	0.60
C.D. at 5%	1.02	1.08	0.95	1.27	1.82

4.3.4 Pod length

The pod length differed significantly among the vigour levels. Significantly higher pod length (17.35 cm) was recorded in high vigour seeds of V_0 followed by V_1 (15.72 cm) which was onpar with medium vigour seeds V_2 (15.65 cm). Whereas, the lowest pod length was recorded in low vigour seeds of V_5 (13.77 cm), V_4 (14.22 cm) and medium vigour levels V_3 (14.40 cm) were onpar with each other.

4.3.5 Pod weight per plant

The pod weight per plant differed significantly among the vigour levels. Pod weight decreased with decline in vigour levels from V_0 to V_5. The highest pod weight was recorded in high vigour level of V_0 (44.77 g) and V_1 (41.05 g) followed by medium vigour level V_2 (33.40 g) and V_3 (21.65 g). The lowest pod weight was recorded in low vigour seeds of V_4 (20.10 g) and V_5 (19.00 g) are on par with each other.

4.3.6 Number of seeds per pod

Number of seeds per pod showed significant differences among the vigour levels. More number of seeds were observed in high vigour seeds of V_0 (5.69) which was significantly superior to all other vigour levels.

4.3.7 Number of seeds per plant

Number of seeds per plant differed significantly among the vigour levels. The number of seeds decreased with

Table 4.6 : Yield components as influenced by vigour levels in Fench bean Cv. Arka Komal

Treatments	Number of seeds per pod	Number of seeds per plant	100 Seed weight (g)	Seed yield/ plant (g)	Seed yield/ plot (g)	Seed yield ha (kg)
V_0 Control	5.67	126.77	31.46	38.50	1605	1783
V_1 1 Day AA	5.48	114.40	29.67	32.77	1358	1509
V_2 2 Day AA	5.42	103.92	27.87	28.87	1155	1283
V_3 3 Day AA	5.32	87.91	25.08	21.97	868	965
V_4 4 Day AA	5.12	81.20	21.67	16.22	595	662
V_5 5 Day AA	4.98	65.00	19.55	13.90	479	532
Mean	5.33	96.53	25.87	25.30	1010	1122
SEm±	0.20	1.48	0.37	0.49	20	23
C.D. at 5%	0.60	4.48	1.11	1.39	62	69

the decrase in the vigour level. The number of seeds ranged from 126.77 in highest vigour level V_0 to 65.00 in lowest vigour level V_5 and V_1 (114.40), V_2 (103.92), V_3 (87.91) and V_4 (81.20) were in between.

4.3.8 Hundred seed weight

Hundred seed weight decreased significantly from 31.46 g to 19.55 g with decrease in vigour levels from V_0 to V_5. Highest test weight was recorded in high vigour level V_0 (31.46 g) followed by V_1 (29.67 g). The medium seed weight was recorded in medium vigour level of V_2 (27.87 g) followed by V_3 (25.08 g). Whereas, low vigour levels V_4 and V_5 recorded lowest test weight of 21.67 g and 19.55 g, respectively.

4.3.9 Seed yield per plant (g)

Seed yield per plant decreased significantly with decrease in vigour levels. Highest seed yield was recorded in high vigour V_0 (38.50 g) which was significantly superior over all other vigour levels. The lowest seed yield (13.90 g) was recorded in low vigour level V_5.

4.3.10 Seed yield per plot

Seed yield per plot decreased significantly from 1605 to 479 g with decrease in vigour levels from V_0 to V_5. Significantly higher seed yield per plot was recorded in high

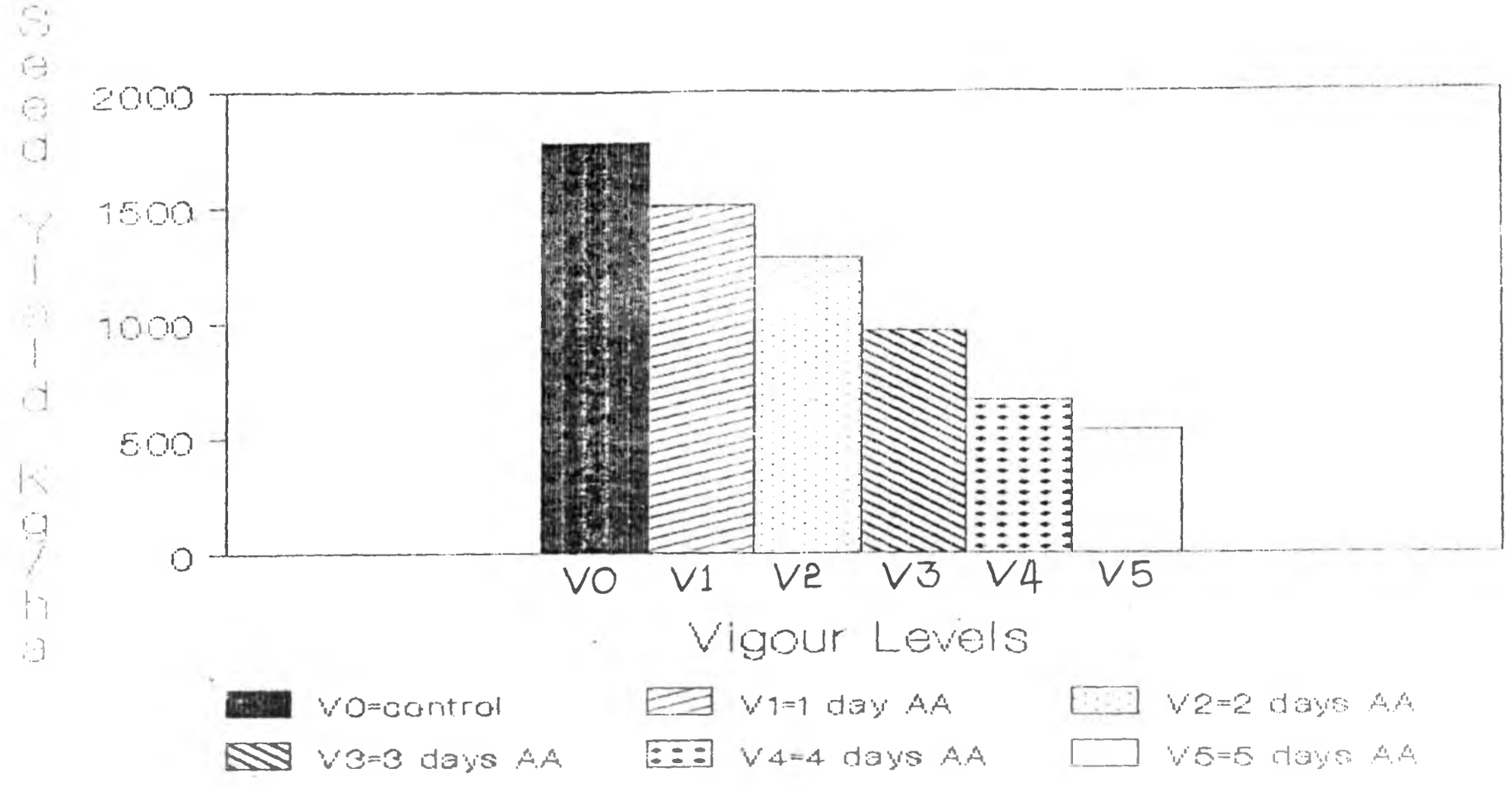

Fig.4 :Seed Yield as influenced by different vigour levels in French bean Cv. Arka Komal

vigour levels of V_0 (1605 g) and V_1 (1358 g). The lowest seed yield of 479 g was obtained in lower vigour level V_5 followed by V_4 (595 g) which were significantly inferior to all other vigour levels. The medium vigour levels V_2 (1155 g) and V_3 (868) g) gave moderately higher yield but difference were also significant among each other.

4.3.11 Seed yeild per hectare

Seed yield per ha drastically decreased with decline in vigour from V_0 to V_5. Significantly maximum seed yield (1783 kg/ha) was recorded in high vigour level V_0 followed by V_1 (1509 kg/ha). The lowest seed yield (532 kg/ha) was obtained in low vigour level V_5 which was significantly inferior to all other vigour levels. The medium vigour levels V_2 (1283 kg/ha) and V_3 gave moderately higher yields. The per cent reduction in yield per hectare over high vigour level V_0 was 15.36, 28.04, 45.86, 62.87 and 70.16 per cent in vigour levels, V_1, V_2, V_3, V_4 and V_5 respectively.

4.4 SEED QUALITY PARAMETERS

The data on different seed quality parameters such has germination, root and shoot length, vigour index and electrical conductivity after harvest of the crop are presented in the Table 4.7.

4.4.1 Germination (%)

Per cent germination did not differ significantly

Table 4.7 : Germination and quality parameters of freshly harvested seeds as influenced by seed vigour levels in French bean Cv.Arka Komal.

Treatments	Germination percentage	Shoot length (cm)	Root length (cm)	Vigour index	Electrical conductivity (u mhos/cm^2)	Seed microflora % infection
V_0 Control	86.00	9.50	12.26	1872	937	12.00
V_1 1 Day AA	85.33	9 00	11.76	1772	984	13.00
V_2 2 Days AA	82.00	8.76	11.03	1623	1014	12.66
V_3 3 Daya AA	84.66	8.43	10.60	1518	1003	10.67
V_4 4 Days AA	84.65	8.23	9.83	1473	1051	11.00
V_5 5 Days AA	82.00	7.78	9.53	1349	1081	13.00
Mean	83.83	8.61	10.83	1601	1011	12.05
SEm±	1.05	0.40	0.29	47	29	0.96
C.D. at 5%	NS	NS	0.90	145	NS	NS

among each other. However,maximum germination was obtained in high vigour seeds V0 (86%) and V1 (85.33%).The lowest germination of 82% was recorded in vigour level V5.

4.4.2 Shoot length

Shoot length did not differ significantly among the vigour levels. However, the marginal decrease in shoot length was noticed with decrease in vigour level .

4.4.3 Root length

Root length differed significantly among vigour levels. The highest root length was recorded in high vigour level seed V_0 (12.26 cm) which was on par with V_1 (11.765 cm). The lowest root length was noticed in low vigour seeds V_5 (9.53 cm) was onpar with V_4 (9.83 cm). Whereas, the medium vigour seeds V_2 and V_3 are also onpar with each other.

4.4.4 Vigour index

Vigour index calculated on the basis of seedling length decreased significantly with decrease in vigour levels. Highest vigour index was recorded in high vigour seeds V_0 (1876) which was onpar with V_1 (1518) recorded moderately high vigour index than the low vigour seeds V_4 (1473) and V_5 (1349) were onpar with each other.

4.4.5 Electrical conductivity (μ mhos/cm^2)

Electrical conductivity of seeds produced from different vigour levels did not differ significantly. However, the marginal increase in EC was noticed with decrease in vigour levels, 937 in V_0 and 1081 in V_5.

4.4.6 Seed Microflora

The per cent infection of seeds produced from different vigour levels did not differ each other. However maximum infection was noticed in V1 and V5 (13%) and lowest in V0 and V4.

CHAPTER - V

DISCUSSION

V. DISCUSSION

In the present investigation an attempt was made to study the effects of different seed vigour levels on seed quality through various laboratory tests and field performance of French bean Cv. Arka komal. The results of the investigations are discussed in this chapter.

5.1 LABORATORY STUDIES

Toole et al. (1948) have used delayed expression of full germinability to measure vigour and suggested that the phenomenon could be used to measure vigour of seed lots. The reduction in the physical and physiological manifestation of vigour during ageing could be attributed to irreversible degenerative changes occuring in seeds. According to Gove (1965), it is the fall from the highest to lowest level in vitality character and quality of seeds. In the present study with an increase in ageing period, from zero to five days there was progressive decline in seed quality interms of viability, germinability, speed of germination, seedling growth rate, root-shoot length, electrical conductivity, field emergence and vigour index was observed.

Standard germination percentage significantly decline (97.5 to 78.5%) as the ageing period progressed (0 to 5 days) (Fig.1). These results are in confirmity with Sawimy

and Taylor (1987) in French bean. This might be attributed to influence of adverse condition experienced by the seed during ageing. The reaction of oxygen and lipid constituents of the cellular membrance to form free radicle intermediates was considered to be the basic reason for ageing and senesence of cells (Tappel, 1973).

Similar to germination, seedling and root, shoot length , seedling fresh weight and dry weight also declined with increase in ageing period. The decrease in root length - shoot length, seedling dry weight with increased ageing period were also reported by Dey and Mukerjee (1986), Hussani et al. (1988) and Ramamoorthy et al. (1989). The poor germinability might be due to the loss of cellular membrane integrity which consequently leads to leaching of solutes and inter cellular disorganization, which impare the growth of seedling by depleting substance and metabolic intermediates (Navtiyal et al., 1988).

The seedling vigour computed as vigour index based on seed germination seedling length, shoot length and dry weight basis were found to be maximum in high levels compared to low vigour seeds. The reduced seedling vigour in low vigour seed is due to the retarded germination process resulting in reduced seedling length and low dry matter production in seedling. Abdulla and Roberts (1969) and Gelmond et al. (1978) recorded similar observation in seed vigour in winged bean barley and sorghum.

The electrical conductivity of seed leachates substantially increased with increase in ageing period from zero to five days (Fig.2). The increase in electrical conductivity in low vigour seeds was due to the loss in permeability of cellular membrance and release of electrolytes in the inbibing media,which is a clear indication of progress in the deterioration. Membrance dedgradation might be due to both hydrolysis of phospholipids by phophoslipase and phospholipid autoxidation besides mitochandrial damage as suggested by Berjack and Villiers (1972).

Speed of germination and seedling growth rate reduced linearly with decline in vigour levels. High vigour level seeds exhibited higher speed of germination and seedling growth rate than poor vigour level seeds. Reduction in speed of germination was due to low vigour level similar results were also reported by Gelmond et al. (1978), Gray (1984), Karuna and Aswathaiah (1989) and Ravider (1990).

High vigour seed lot scored maximum T_Z vigour (93.75%) , while the medium and low vigour seeds scored significantly low T_Z vigour percentage. Sung and Chen (1988) observed positive relationship with seedling growth and formazan production, suggesting tetrazolium treatment test as a reliable method for evaluating seedling vigour in cereals. Per cent field emergence reduced linearly with decrease in vigour levels (Fig.3). High

vigour seeds recorded maximum field emergence and there was corresponding reduction in low vigour seeds. Such decline in field emergence was due to reduced germination and seedling vigour. Chen et al. (1972) opined that stand establishment was influenced by physiological condition of the seed. Schuch and Lin (1982) observed reduced field emergence with increase in duration of ageing in wheat. Similar observation were also made by Hussaini et al. (1988) in corn.

5.2 FIELD STUDIES

5.2.1 Growth Parameters

The plant population at harvest reduced linearly with decrease in vigour levels. High vigour seeds recorded maximum plant population and corresponding decline in plant population was observed in medium and low vigour levels, such decline in plant population was due to poor germination, seedling vigour and high mortality. Chen et al. (1972) opined that stand establishment was influenced by physiological condition of the seed.

A decreasing trend was observed in plant height from high nvigour level (V_0) to low vigour level (V_5) ranging from 57.25 cm to 45.00 cm. This may due to the decrease in germination and seedling vigour. Camargo and Vaughan (1973) and Ogundipe (1984) reported that plants raised from low vigour seed gave lesser plan height as compared to high vigour seeds in sorghum. Venkateswar Rao (1990) obseerved linear decrease in plant height with decrease in level of

germination at all stages of crop growth in sorghum hybrids CHS-9 similar results were also reported by Roberts (1972) and Hussani et al. (1988) maize.

Number of primary branches decreased linearly with decrease in vigour level. The high vigour level V_0 recorded significantly higher number of primary branches then the vigour level V_1 to V_5 similar results were reported by Jones and Gamble (1984) in Soybean.

The dry matter production recorded a significant decrease from vigour level V_0 (66.10 g) to V_5 (43.10 g). The decrease in dry matter production from high vigour level to low level may be due reduced plant growth, less number of branches per plant, lesser pod yield. Similar observations were made by Hussaini et al. (1988) and Lin (1982).

There was an increasing trend for days taken to flower initiation, 50 per cent flowering and complete flowering with decrease in vigour level. Plants raised from high vigour seeds started and completed flowering much earlier as compared to low vigour level seeds. Similar trend was observed in cowpea (Vechi, 1970) and in sunflower (Ravinder, 1990). Whereas duration of flowering was found to be non significant among different vigour levels.

5.3.1 Yield and Yield Components

The seed yield/ha reduced significantly with decrease in vigour level. The maximum yield was recorded in higher

vigour level V_0 (1782 kg/ha). The yield was reduced by 15.33 per cent in V_1, 28.04 per cent in V_2, 45.85 per cent in V_3, 62.87 per cent in V_4 and 70.16 per cent in V_5.

The reduction in yield may be due to the poor performance in surviving plants, produced by low vigour seeds. This is in confirmity with the results obtained by Funk et al. (1962) and Grabe (1967) in maize.

The yield components such as number of pods per plant, pod length, pod weight per plant, number of seeds per plant, number of seeds per pod and test weight of the seed showed decreasing trend with decrease in vigour levels. The low yield obtained with low vigour seed is mainly attributed to reduced plant population less number of pod per plant, less number of matured pods per plants, more number of immature pods per plant and finally less pod yield per plant. (Table 4 and Fig. 4)

Lin (1990) observed reduced plant population and seed yield with decrease in vigour levels. A direct association between a decline in germination, reduction in plant stand and yield was reported by Roberts (1972), Johnson and Wax (1981) (Fig.4). Similarly, a positive association between germination levels and yield components and yield in sorghum hybrids was observed by Vankateshwara Rao (1990) in sorghum hybrid and Ravinder (1990) in sunflower.

5.4 SEED QUALITY PARAMETERS AFTER HARVEST

The germination percentage, shoot length, root length and vigour index by seedling length basis showed a decreasing trend with decrease in vigour levels. Whereas the electrical conductivity of seed leachates showed an increasing trend with decrease in vigour levels.

The above results indicate that high vigour seeds V_0 produced high quality seed which recorded high germination (86%), shoot length (9.5 cm), root length (12.26 cm), vigour index (1772) and very low EC (937) as compared to low vigour seeds (V_5) with germination percentage (82.00%), shoot length (7.78 cm), root length (9.53 cm) and vigour index (1349) with very high EC (1081)per cent infection.

5.5 Future Line of Work

Further studies are needed prediction of actual age of seeds by storing the seeds under different conditions over a period of time and quality parameters can be assessed.

Correlation studies between vigour tests and field studies are most useful for assessment of vigour in french bean seeds.

CHAPTER - VI

SUMMARY

VI. SUMMARY

French bean cultivar Arka komal with an initial germination of 98 per cent was subjected for accelerated ageing for a period of one to five days. Five vigour levels were established to study the effect of different vigour levels in laboratory and field performance. The seed deterioration was studied by various laboratory tests, such as standard germination, root and shoot length, vigour index, speed of germination, Tz vigour, seedling growth rate, electrical conductivity test and dry matter production. The influence of seed vigour on field performance was studied in terms of field emergence, growth, development of flower, pod set, seed set and quality of seed thus produced.

Germination percentage differed significantly among treatment with the maximum germination percentage found at V_0 (97.50%) and minimum at V_5 (78.50%). The root length differed significantly among treatments, whereas the shoot length did not differ significantly among treatments.

A linear reduction in fresh weight as well as dry weight was observed with decrease in vigour level one to six. Similar trend was observed for vigour index in different paramters like seedling length, shoot length and dry weight of seedling.

Vigour levels significantly affected the speed of germination and seedling growth rate. There was a linear and significant reduction in speed of germination and seedling growth rate as the vigour level decreased from high vigour to low vigour level (V_0 to V_5).

Electrical conductivity increased with an increase in the duration of accelerated ageing, due to an increase in the leachates from aged seeds. T_Z vigour results showed a similar trend as that of standard germination. High vigour seeds V_0 and V_1 showed higher per cent of T_Z vigour whereas low vigour level V_5 recorded lower values for T_Z vigour test.

Vigour level V_0 resulted in highest field emergence (91.25%) while, vigour level V_5 recorded the lowest field emergence (62.0%). A linear and significant reduction in field emergence was observed with the decrease in vigour levels from V_0 to V_5.

Field emergence per cent and plant stand generally followed the trend of germination percentage among the vigour level. Plant stand at harvest was found to be differ significantly among different vigour levels.

There was a significant reduction in plant height (57.25 cm to 45.0 cm), number of branches (3.75 to 2.25) and dry matter production per plant (66.10 to 43.17 g) with the decrease in vigour levels (V_0 to V_5).

Days taken to flower initiation, 50 per cent flowering and complete flowering indicated a significant delay, with the decrease in vigour levels, whereas, the duration of flowering did not vary with different vigour levels.

Seed yield per hectare showed linear and significant decline with decrease vigour levels. The highest seed yield (1783 kg) was recorded in V_0 while, it was decreased by 15.36, 28.04, 45.86, 62.87 and 70.16 per cent in V_1 (1509 kg), V_2 (1285 kg), V_3 (965 kg), V_4 (662 kg) and V_5 (532 kg), respectively. The yield components such as number of seeds per pod, number of seeds per plant, test weight, seed yield per plant, seed yield per plot showed a similar trend.

Vigour levels had a direct influence on number of pods per plant, number of mature and inmatured pods per plant, pod length and pod weight.

The seeds produced from different vigour levels were tested for per cent germination, shoot length, root length and vigour index and were found to be non significant. However, shoot length showed a decreasing trend with a decrease in vigour level. While electrical conductivity showed an increasing trend with a decrease in vigour level (V_0 to V_5).

On the basis of the results obtained in these studies it can be concluded that seed vigour has influence on various seed quality parameters in the laboratory, obtained from seed lots having high initial germination exhibited full yield potential. A further reduction in germination resulted in a significant reduction in the yield from 1783 to 532 Kg/ha with decrease in vigour levels V_0 to V_5. Early flower initiation was observed in V_0 (20.37) followed by V_1 (20.62) and V_2 (21.50) which were on par with V_3 (22.00). The initiation of flowering delayed in low vigour seeds V_5 (24.25) and V_4 (23.00).

CHAPTER - VII

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VII. REFERENCES

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