Studies on physiological behaviour of wal (*Lablab purpureus*L.) genotypes under moisture stress condition

by

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PLANT PHYSIOLOGY

by

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CERTIFICATE

This is to certify that, the thesis entitled "**Studies on physiological behaviour of wal(*Lablab purpureus*L.) genotypes under moisture stress condition**" submitted to the Faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra State in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (AGRICULTURE)**, in **PLANT PHYSIOLOGY** embodies the result of a piece of bona-fide research carried out by **Ms. MANISHA DAMODAR SHIRODKAR (Regd. No. 2355)** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma or published in other form. All the assistance and help received during this course of investigation and the sources of literature have been duly acknowledged by her.

Place: Dapoli
Date : August 2016

(S. G. Mahadik)
Chairman, Advisory Committee
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MANISHA D. SHIRODKAR

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Thesis Title	:	"Studies on physiological behaviour of wal (*Lablab purpureus* L.) genotypes under moisture stress condition."
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ABSTRACT

A field experiment was conducted at agricultural research botany farm, College of Agriculture, Dapoli to study the "Studies on physiological behaviour of Wal (*Lablab purpureus*L.) genotypes under moisture stress condition**."** during *Rabi* season 2015-16. The genotypes were grown in spilt plot design with three replications provided with eight main treatments (moisture stress level) and six sub treatments (six different genotypes). The experiment consisted of 8 main treatments comprising of I_0: No irrigation after 30 DAS, I_1: One irrigation after 30 DAS, I_2: Two irrigations at 10 days interval, I_3: Three irrigations at 10 days interval, I_4: Four irrigations at 10 days interval, I_5: Five irrigations at 10 days interval, I_6: Six irrigation at 10 days interval, I_7: Seven irrigations at 10 days interval and 6 six sub treatments comprising of 6 (Genotypes) namely:G_1:No.30, G_2: No.33, G_3: No.54, G_4: No.48, G_5: No.64 and G_6: Kokan Wal-2 (check).

Among the eight moisture stress levels, I_7(seven irrigations at 10 days interval) recorded maximum plant height, number of leaves,

leaf area, leaf area index, absolute growth rate, relative growth rate, leaf area ratio, leaf area duration, total chlorophyll and number of branches. Whereas maximum number of pods per plant, number seeds per pod, 100 grain weight and seed yield was recorded in I_4 (four irrigation at 10 days interval). Accumulation of maximum proline was found at I_0(no irrigation after 30 DAS).

Among the genotypes used for the study, genotype G_2(line no.33) had recorded maximum plant height, number of leaves, leaf area, leaf area index, absolute growth rate, relative growth rate, leaf area ratio, leaf area duration, total chlorophyll, number of branches Number of pods per plant, seed per pod, 100 grain weight and seed yield per plant. While considering the drought tolerant capacity of genotypes, genotype G_2(line no.33) had higher accumulation of proline content, relative water content and water potential at severe moisture stress treatment. These biochemical response changes confer that genotype G_2(line no.33) had maximum drought tolerant capacity than other genotypes used for the study purpose.When compared seed yield recorded due to various moisture stress levels, I_4 *i.e.* four irrigations at 10 days interval after 30 DAS was found most optimum as it recorded higher seed yield than I_5 (five irrigations at 10 days interval), I_6 (six irrigations at 10 days interval) and I_7 (seven irrigations at 10 days interval).

A wide range of variability exists for different morpho-physiological and biochemical parameters among six genotypes of wal under different moisture stress conditions. Among the six genotypes of wal studied under different moisture stress conditions, genotype G_2 recorded high yield under I_4 (four irrigation at 10 days interval) moisture stress condition, owing to their high efficiency to produce maximum economical yield.Four irrigations at 10 days interval after 30 days after sowing (I_4) could be considered as the optimum level of irrigation frequency for higher yield with saving in

water. This information may be helpful for better understanding of concept of critical stages of vegetative and reproductive growth and its application to the effect of drought at various aspects of growth and yield of wal. It can be employed for the improvement programme as well as efficient management practices for wal production in drought prone areas.

CHAPTER I

INTRODUCTION

Pulses have been recognized as a major source of vegetable proteins. They play a vital role in maintaining soil fertility by fixing atmospheric nitrogen.

Lablab purpureus (L.) Sweet belongs to the family of Fabaceae and is also known as Hyacinth bean, Egyptian kidney bean (Verdcourt 1979). Lablab is known for its adaptation to a wide range of environmental conditions (Kimani *et al.* 2012), which can be to some extent explained by its great natural genetic diversity and distribution. Lablab is an ancient domesticated crop, widely distributed in Africa, the Indian sub-continent and Southeast Asia,where it has been used as a grain legume and vegetable for more than 3500 years (Maass *et al.* 2005). Lablab is now widely distributed throughout the tropics and subtropics (Kimani *et al.* 2012), where it has become naturalised in some areas (Tefera 2006).Lablab thrives in regions where annual temperatures range between 18^0C and 30°C.

Despite its large agro-morphological diversity in South-Asia, its origin, however, is considered to be in Africa, which is the only continent where wild plants in greater variation have been recorded to occur naturally (Maass *et al.*, 2010). Lablab is, since 1970s, listed as a minor and neglected crop in most areas, despite its long tradition, great diversity and its adoption to a diverse range of environmental conditions (Kimani *et al.* 2012).

The wild forms of lablab are believed to have originated in India (Deka and Sarkar 1990) and were introduced into Africa from Southeast Asia during the eighth century.

The plant is variable due to extensive breeding in cultivation, but in general, they are annual or short-lived perennial vines. The wild species is perennial. The thick stems can reach six meters in length.

The leaves are made up of three pointed leaflets each up to 15 centimetres long. They may be hairy on the undersides. The inflorescence is made up of racemes of many flowers. Some cultivars have white flowers, and others may have purplish or blue.The fruit is a legume pod variable in shape, size, and colour. It is usually several centimetres long and bright purple to pale green.It contains up to four seeds. The seeds are white, brown, red, or black depending on the cultivar, sometimes with a white hilum. Wild plants have mottled seeds. The seed is about a centimetre long.

Lablab is rich in nutritive value. The green pods contain about 3.8 percent protein with moisture 86.1 percent, carbohydrates 6.7 percent and fat 0.7 percent. It also contain 1.8 percent fibre and 0.9 percent ash. The approximate composition of the dry pulse is 24.9 percent protein with 9.6 percent moisture, 60.1 percent carbohydrates, 0.8 percent fat, 1.8 percent fibre and 3.2 percent ash content.

Lablab purpureus combines a great number of qualities that can be used successfully under various conditions. Its first advantage is its adaptability. Not only it is drought resistant, it is able to grow in a diverse range of environmental conditions worldwide.As a multipurpose legume, lablab is used as a pulse crop for human consumption, as a fodder crop for livestock, as a rotational and cover crop as well as a pioneer species to improve soil fertility and soil organic matter (Hill *et al.* 2006). Additionally, it is even used as herbal medicine or for ornamental purposes (Maass *et al.* 2010). In terms of soil amendments, lablab's dense green cover can help to protect the soil against desiccation and decreases erosion by wind and water when used as a cover crop (Mureithi *et al.* 2003). Additionally, the use as green manure offers great potential for soil conservation strategies and stabilization of chemical and physical soil properties (Whitbread *et al.* 2011).

India is the largest producer of pulses in the world with 25% share in global production. During 2009-2010, in India, the total production of pulses was 14.56 million tonnes from an area of 23.63 million hectares, with average productivity of 625 kg/ha (Ali, *et al.* 2008). In Maharashtra, pulses are cultivated on 21756 hectares with a productivity of about 703 kg/ha.

Water deficiency is a major factor that reduces the potential productivity of plants in the tropics. Different mechanisms contribute to drought resistance in plants. These include the avoidance of plant water deficits by drought escape (short duration), water conservation, and more efficient water uptake (Jones, 1983). More than one of these mechanisms can be used as a defence strategy by plants.

Drought stress is defined as the condition when a plant's water demand is not met by the supply, leading to a reduced plant water status (Blum 2005).Drought resistance is a broad term that has been used to describe adaptation mechanisms of crops to water-limited environments. Plants may also use more than one adaptation mechanism (Hall and Naidu 2004). According to Blum (2005), a genotype is considered to be relatively more drought-resistant if it produces better yields under severe drought stress conditions compared to other genotypes. Additionally, drought resistance in its physiological context interacts with the magnitude and the timing of stress.

Generally pulses are cultivated largely on dryland condition as a rainfed crop by employing low input and poor technology. However, there has not been any measurable success in enhancing and stabilizing the productivity of the grain legumes even though they constitute the major crop component of drought areas. The reasons for failure and stabilizing the productivity of pulse crops are quite clear.Many pulse crops are inherently adapted to abiotic stress

condition by retention of several ancestral wild characters like indeterminate growth habit, photo-thermosensivity, long maturity period, staggered flowering, *etc*. In process of adaptation to stress, many pulse crops have acquired an aggressive growth habit with the result that most of the energy is diverted to production of vegetative parts leading to low harvest index. The understanding of the mechanism explaining the resistance of lablab varieties to drought is of extreme importance for improving the production of this grain legume. It is well known fact that lablab has greater developmental plasticity than some of the cultivated legumes which imparts it drought tolerance. Evaluation of such genotypes along with ancestral types under varying soil moisture stress conditions may provide information on crop indices which could be suitably used in quantification of stress in terms of plant parameters such as drought tolerance, high chlorophyll content and high proline content.

The present study is thus aimed at to reveal the component traits responsible for the mechanism of sustaining yield levels in water deficit conditions with support of growth analysis and biochemical investigation on six genotypes of lablab with the following objectives:

1. To investigate the impact of moisture stress on morpho-physiological traits of wal genotypes.
2. To study the impact of moisture stress on biochemical parameters of wal genotypes.
3. To find out moisture stress tolerant high yielding genotypes of wal.

CHAPTER II

REVIEW OF LITERATURE

Abiotic stresses negatively influence the yield of the crop upto 70%.Tolerance to abiotic stresses is very complex, due to the intricate of interactions between stress factors and various molecular, biochemical and physiological phenomena affecting plant growth and development. Water stress is the most prevalent abiotic stress that limits global plant growth and productivity more severely than that that caused by any other environmental stresses. Water deficit occurs when the availability of water is insufficient to maintain the plant growth, photosynthesis and transpiration, often stunting vegetative growth, inducing flower abortion and promoting leaf senescence (Blum 2005).

The literature available in the lines of present investigation in lablab and other crops is presented in this chapter under the following headings

2.1 **Growth observations**

2.2 **Growth analysis**

2.3 **Physiological parameters**

2.4 **Yield and yield attributing characters**

2.1 **Growth observations**

Mwanamwenge *et al.* (1998) assessed the effect of water stress (S_0-control, S_1- water stress at floral initiation stage, S_2- water stress at flowering, S_3- water stress at podding) during floral initiation, flowering and podding on the growth and yield of three genotypes (ACC286, Fiord and Icarus) faba bean (*Vicinia faba* L.). The results concluded that, there was no significant difference in plant height on the main stem at maturity for any genotype. However among the different stress treatments, genotype Icarus recorded maximum plant height (108.8cm) at S_2 (water stress at flowering) condition.There was no significant difference in the number of leaves at maturity for any ger However among the different

stress treatments, genotype Fiord recorded maximum number of leaves (33) at S_1 (water stress at floral initiation) condition.

Shinde (1998) studied the effect of elevation of water stress by potassium and growth regulators in five green legumes. Among them, lablab with no stress had found with maximum plant height, maximum number of leaves and maximum leaf area.

Fening*et. al.*(2009) studied the response of three forage legumes (*Centrosema pubescens*, *Lablab purpureus* and *Stylosanthes guianensis*) to soilmoisture stress (100, 75, 50, and 25% field capacity) at Ghana conditions and reported that,soil moisture stress caused differences in plant height which varied from 34.1 to 53.6 cm in the order 100%> 75%>50% >25% field capacity. The magnitude of moisture stress in reducing plant height varied with the type of cover crop in the order of Lablab (66%) > Centrosema (19%) > Stylosanthes (13%).

Groteluschen (2014) studied the promising multipurpose legume *Lablab purpureus* (L.) in smallholder farming systems of Eastern Kenya. The results indicated that genotype CPI 52535 had recorded maximum plant height.

Hasan *et.al.* (2014) studied forage yield and quality of lablab (*Lablab purpureus* L. Sweet) intercropped with maize (*Zea mays* L.) with flooded irrigation system in the semi-arid zone of Nigeria. The research was conducted in three consecutive years (2009, 2010, 2011) with two factors, age of harvest (6, 9, 12, 15 and 18 WAS) and irrigation schedule (3, 6 and 9 days interval). Among the factors irrigation schedule and age of harvest showed significant difference in plant height. Among irrigation treatments, 9 days irrigation interval recorded 119.15 cm height. Irrigation schedule had not shown significant difference for the number of leaves. Among the irrigation schedule treatment, three days interval, six days interval

and nine days interval recorded 21.70, 22.15 and 21.74 number of leaves, respectively.

Kataria and Singh (2014) assessed the effect of applied potassium in selected *Vigna radiata* L. genotypes (SML-668 and MH-318) under different stress condition (control-12% soil moisture content and stress 4.5% soil moisture content). The results indicated that at stress condition in both the genotypes of mungbean showed increasing trend for leaf area from vegetative to flowering stage, whereas there was a sharp decline in leaf area from flowering to pod formation stage. Genotype SML-668 recorded maximum leaf area (80.2, 126.0 and 61.1cm^2) than MH-318(61.5, 91.9 and 49.6 cm^2) respectively at vegetative, flowering and pod flowering stage.

Mustapha *et al.* (2014) evaluated the effect of moisture stress (at vegetative, flowering and post flowering stage) on the growth parameters of different soybean genotypes. The results indicated that at stress conditions in all the genotypes of soybean showed increasing trend for plant height from stress at vegetative stage (36.82 cm) to stress at post flowering stage (51.24 cm). Among the genotypes, TGX1830-2DE genotype recorded maximum plant height (46.78 cm) at eight weeks after planting.Similar trend was also observed for number of leaves and leaf area from stress at vegetative stage to stress at post flowering stage (13.67,86.0 cm^2 and 15.83, 351.5 cm^2)respectively.

Anita and Lakshmi (2015) assessed the growth characters of fodder cowpea varieties as influenced by soil moisture stress levels (pre sowing irrigation and irrigation at IW/CPE ratio 0.4, 0.6 and 0.8). Results revealed that irrigation at pre sowing and irrigation at IW/CPE ratio 0.4 were at par with each other for the plant height. The plant height was significantly higher when irrigated at IW/CPE

ratio of 0.8 (100.83) followed by irrigating at IW/CPE ratio 0.6 (100.14) and irrigating at IW/CPE ratio 0.4 (97.98).

Menon and Savitri (2015) conducted an experiment to mitigate water stress in vegetable cowpea through seed hardening and moisture conservation practices. Among the different treatments used for mitigating water stress, treatment five days irrigation interval recorded maximum plant height of 7.6 cm and maximum number of leaves (10.7) at 45 days after sowing.

2.2 **Dry matter studies**

Parab *et al.* (1991) communicated that, when cowpea crop was subjected to regimes of irrigation stress, leaf area ratio was found to be affected and declined rapidly under stress condition and sudden fall of leaf occurred.

Mwanamwenge *et al.* (1998) assessed the effect of water stress during floral initiation, flowering and podding on the growth and yield of three genotypes (ACC286, Fiord and Icarus) faba bean (*Vicinia faba* L.). Among the genotypes, genotype Fiord recorded minimum total shoot dry matter per plant *i.e.* 29.7 gm, whereas genotype Icarus recorded minimum harvest index *i.e.* 0.10% at S_3 treatment (stress at podding stage).

Shinde (1998) studied the effect of elevation of water stress by potassium and growth regulators in five green legumes. Among them lablab with no stress treatment had found with maximum absolute growth rate and relative growth at initial period of time.

Fening*et. al.*(2009) studied the response of three forage legumes (*Centrosema pubescens*, *Lablab purpureus* and *Stylosanthes guianensis*) to soilmoisture stress (100, 75, 50, and 25% field capacity) at Ghana conditions and reported that, soil moisture stress caused differences in dry matter.Forage crop x soil moisture regime interaction showed a moisture change from 100%

to 25% FC to reduce dry matter of Stylosanthes, Lablab and Centrosema by 85, 60 and 31 per cent respectively.

Hasan *et al.* (2014) studied forage yield and quality of lablab (*Lablab purpureus* L. Sweet) intercropped with maize (*Zea mays* L.) with flood irrigation system in the semi-arid zone of Nigeria. The research was conductedin three consecutive years (2009, 2010, 2011) with two factors, age of harvest (6,9,12,15 and 18 week after sowing) and irrigation schedule (3, 6 and 9 days interval). Harvesting age 6 WAS lablab noted 5.03t/ha dry matter. Age of harvest,has not shown significant difference for leaf area index. The age of harvest 6, 9 and 12 WAS recorded 0.6, 0.5 and 0.6 leaf area index, respectively.

Groteluschen (2014) studied the promising multipurpose legume *Lablab purpureus* (L.) in smallholder farming systems of Eastern Kenya. The results indicated that among the genotypes used for the study, genotype CPI 60795 had recorded maximum, relative growth rate and leaf area index.

Hossain and Hossain (2014) evaluated the response of short duration tropical legume and maize to water stress at Germany and concluded that the significant difference was observed in different plant species with increase of different water regime. Among the species, legume *L. purpurus* showed better response to water stress conditions. In dry treatment, total dry weight was 10 g/pot and in fully watered condition it was near to 20 g/pot in *P. vulgaris.*

Mustapha *et al.* (2014) evaluated the effect of moisture stress (at vegetative, flowering and post flowering stage) on the growth parameters of different soybean genotypes. The results indicated that at stress conditions in all the genotypes of soybean showed increasing trend for dry matter from stress at vegetative stage to stress at post flowering stage. Among the genotypes, TGX1817-12E

genotypes produced maximum dry matter (4.4 t/ha) at post flowering stage seven weeks after planting.

2.3 **Physiological parameters**

Purushottam *et al.,* (1998), concluded that, there was increase in proline content in groundnut leaves when crop was subjected to moisture stress.

Shinde (1998) studied the effect of elevation of water stress by potassium and growth regulators in five green legumes. Among them, lablab with no stress treatment had found with maximum total chlorophyll content.

Hall and Naidu (2004) studied the genotypic differences for drought resistance in *Lablab purpureus* L. and stated that as the drought period increased, relative water content decreases in all genotypes. Among the genotypes CPI 106504, Cv. Highworth, CPI 106548, P5309, CPI 51564 and CPI 29803 recorded maximum relative water content in drought conditions.

Kala *et al.* (2008) observed the effect of moisture stress on leaf proline, proteins and amino acids content in *Ziziphus species(Z.rotundifolia and Z. nummularia)*at Haryana. Among the species *Z. nummularia* recorded maximum proline (704mg g^{-1}) content, whereas species *Z. rotundifolia* recorded 603.25 mg g^{-1} at 28 days after stress.

Hayatu and Mukhtar (2010) studied physiological responses of drought resistance cowpea genotypes (*Vigna unguiculata* (L.) WALP.) to water stress at Nigeria. Among the seven genotypes (IT00K-835-45, IT00K-901-5, IT96D-610, IT97K-819-118, IT98K-205-8, IT98K-555-1 and IT99K-377-1), the genotype IT00K-901-5 (24.51%) recorded the highest reduction for chlorophyll content and lowest was recorded in IT97K-819-118 (6.64%) under moderate stress condition, whereas under severe water stress, the reduction in

chlorophyll content ranged from 14.82% in IT00K-835-45 to 38.21% in IT99K-377-1.

D'souza and Devraj (2011) studied the specific and non-specific responsed of Hyacinth bean (*Dolichos lablab*) to drought stress at Banglore. The stress conditions significantly elevated the oxidative stress markers, H_2O_2, glutathione, malondialdheyde, proline, ascorbic acid, total phenols and total sugars. Drought enhance antioxidant enyme, peroxidase and gluthaione reductase and reduced catalase in time dependent manner in leaves. The metabolic activity of enyme, beta amalyse and acid phosphatase, increases temporarlly in leaves and roots. Intensity of isozyme co-releated with *in-vitro* levels under stress.

Kumar *et.al.* (2011) studied the effect of polyethylene glycol induced water stress (−0.45MPa and −1.22MPa) on physiological and biochemical responses of Pigeonpea (*Cajanus cajan* L. Millsp.). The results indicated that under progressive mild stress free proline content increased upto 12.17μMgm^{-1} and 54.47 μMgm^{-1} accumulation of proline was observed under progressive severe stress condition.There was an increasing trend in the total chlorophyll content from progressive moderate stress to progressive severe stress condition. It was observed that maximum relative water content (69.33%) was recorded in progressive moderate stress (-0.45MPa), whereas in progressive severe stress (-1.22MPa) it recorded minimum relative water content (40%).

Makbul *et.al.* (2011) studied the changes in anatomical and physiological parameters of soybean under drought stress at Turkey and observed that the chlorophyll content and water potential in the leaves showed significant decrease during the stress treatment. Out of the two treatments (unstressed and stressed), the chlorophyll content recorded in the leaves of unstressed plants was 2.11mg/g, whereas the drought stress leaves recorded 1.52 mg/g. The leaf

water potential recorded in the leaf of unstressed plant was -0.88, whereas the drought stressed leaf recorded -1.18.

Chandrashekhar *et al.* (2012) conducted an experiment to find out the physiological and biochemical changes during moisture stress in banana (cv. Culcutta-4(AA) and Beehee Kela (BB) type) at Bangalore. The results revealed that Culcutta 4 and Beehee Kela (BB) noted -1.824 and -1.518 water potential at stressed condition which was maximum than control (-1.35 and -0.913), respectively.

Maritim *et.al.,* (2013) appraised the effect of water stress (soil moisture level at 34%, 24 % and 16 %) on accumulation of proline and gycinebetaine in tea at Kenya.Imposition of water deficit conditions on tea seedlings caused significant increases in proline leaves in treatments and eight cultivars used for study purpose.

Hossain and Hossain (2014) evaluated the response of short duration tropical legume and maize to water stress at Germany and concluded that the significant difference was observed in different plant species with increase of different water regime. Among the species in dry legume *L. purpurus* showed better response to water stress conditions. At the beginning, in dry watered treatment the photosynthetic rate was below 0 μmol m^{-2} s^{-1} and in fully water condition it was 48 μmol m^{-2} s^{-1}.

Kataria and Singh (2014) assessed the effect of applied potassium in selected *Vigna radiata* L. genotypes (SML-668 and MH-318) under different stress condition (control-12% soil moisture content and stress 4.5% soil moisture content). The results indicated that at stress condition in both the genotypes of mungbean showed increasing trend for chlorophyll content from vegetative to flowering stage, whereas there was a sharp decline in chlorophyll content from flowering to pod formation stage. Genotype SML-668 recorded maximum leaf chlorophyll content (6.25, 7.34

and 4.17) than MH-318(5.96, 6.35 and 3.63) respectively at vegetative, flowering and pod flowering stage.

Sun *et. al.,* (2015) evaluated the proline, sugars and antioxidant enzymes response to drought stress in the leaves of strawberry plants at China and stated that the proline levels were higher in leaves subjected to drought stress than that control levels. Among the drought stress treatment used (control-70-85% WHC, mild stress 50-60% WHC, moderate- 40-50% WHC and severe stress- 30-40% WHC) the proline contents of leaves subjected to mild, moderate and severe drought stress were 1.3 fold, 1.9 fold and 2.3 fold higher than that of control leaves, respectively.The leaves water potential decreases from the mild, moderate and severe stressed plants. The leaf water potential of mild, moderate and severe stress reached -1.93, -2.73 and 3.25 MPa at 10 days after stressing treatment, respectively.

2.4 **Yield and yield attributes**

Mwanamwenge *et al.* (1998) assessed the effect of water stress during floral initiation, flowering and podding on the growth and yield of three genotypes (ACC286, Fiord and Icarus) of faba bean (*Vicinia faba* L.). The results concluded that, there was no significant difference in the number of branches at maturity for any genotype. However among the different stress treatments genotype Fiord recorded maximum number of branches (7.3) at S_1 (water stress at floral initiation) condition. Among the genotypes, genotype ACC286 recorded minimum pods per plant *i.e.* 3.9 at S_3 treatment (stress at podding stage). Among the genotypes, Fiord and Icarus recorded minimum number of grains per pod *i.e.* 1.5 at S_3 treatment (stress at podding stage). There was no significant difference in hundred grain weight at maturity for any genotype. However among the different stress treatments, genotype ACC286 recorded maximum hundred grain weight (1.54 g.) at S_2 (water stress at flowering)

condition. Among the genotypes, genotype Icarus recorded minimum grain yield per plant *i.e.* 3.5 g. at S_3 treatment (stress at podding stage).

Rao *et al.,* (2003) studied the effect of drought and temperature stress on plant growth and nutrient uptake of grain legumes *viz.,* green gram, black gram and cowpea. They reported that yield and yield contributing characters such as number of pods, number of seeds per pod and 100 seed weight was drastically reduced under stressed condition.

Ogedegbe*et. al.* (2012) studied the seed yield and yield attributes of lablab (*Lablab purpureus* L. sweet) as influenced by phosphorus application (0,12,24,36 kg P/ha), cutting height (10, 20 cm)and age of cutting (6, 12, 18 WAS) in a semi-arid environment of Nigera.The results indicated that Phosphorus application and cutting height did not cause significant differences in seedyield of lablab (average yield 592 kg/ha).In control treatment, 27.5 number of pods per plant and 3.2 number of seeds per pods were recorded.

Groteluschen (2014) studied the promising multipurpose legume *Lablab purpureus* (L.) in smallholder farming systems of Eastern Kenya. The results indicated that genotype CPI 60795 recorded maximum grain yield and harvest index.

Kumar and Singh (2014) estimated the effective selection criteria to determine moisture stress tolerance in Indian mustard (*Brassica juncea)* from 32 genotypes at Hissar. Scientist studied the Moisture Stress Intensity (MSI), Mean productivity Index (MPI) and Moisture Stress Tolerance (MST). Higher mean productivity index favour the higher yield potential and lower moisture stress tolerance. Among the genotypes studied, the genotype NDRS-2003-3 recorded the poorest productivity and had low yield potential but the high moisture stress tolerance. Higher the value of Moisture stress tolerance, lower the tolerance capacity. Among the genotype

studied, genotype SKM 817 was observed for the smallest value and exhibited tolerance to moisture stress.

Mustapha *et al.* (2014) evaluated the effect of moisture stress (at vegetative, flowering and post flowering stage) on the growth parameters of different soybean genotypes. The results indicated that at stress conditions in all the genotypes of soybean showed increasing trend for number of branches from vegetative (4.0) to post flowering stage (6.3). Among the genotypes, TGX5326-02D genotypes recorded maximum number of branches (8.5) at post flowering stage.

Siahbidi *et al.* (2014) observed the responses of sunflower genotypes (Farrokh, Ghaseem and SHF 81-90) to water stress (irrigation in 25, 50 and 75% depletion of soil moisture) and super absorbant (0, 100 and 200 kg/ha). Among the genotypes Ghasem has recorded 100 seed weight of 6.2, 6.6 and 6.8 gm at full stress, semi stress and full irrigation condition, respectively. The results indicated that seed yield of all the genotypes were affected in water deficit and super absorbant. Among the genotypes Farrokh has recorded seed yield of 3071, 4583 and 5524 kg/ha at full stress, semi stress and full irrigation condition, respectively.

Anita and Lakshmi (2015) assessed the growth characters of fodder cowpea varieties as influenced by soil moisture stress levels (pre sowing irrigation and irrigation at IW/CPE ratio 0.4, 0.6 and 0.8). Results revealed that irrigation at pre-sowing and irrigation at IW/CPE ratio 0.4 were at par with each other for the number of branches. The number of branches were significantly higher when irrigated at IW/CPE ratio of 0.8 (4.57) followed by irrigating at IW/CPE ratio 0.6 (4.22) and irrigating at IW/CPE ratio 0.4 (3.80).

Menon and Savitri (2015) conducted an experiment to mitigate water stress in vegetable cowpea through seed hardening and moisture conservation practices. Among the different treatments

used for mitigating water stress, treatment of five days irrigation interval recorded maximum number of branches (2.3), maximum number of pods (4.0) and maximum number of seeds per pod (14.8).

CHAPTER III

MATERILAS AND METHODS

The present investigation on "Studies on physiological behaviour of Wal (*Lablab purpureus*L.) genotypes under moisture stress condition" was carried out at Agricultural Botany Research Farm, Department of Agricultural botany, College of Agriculture, Dapoli, during the year 2015-2016. The detailed information regarding the material used and methodology followed during the entire investigation, is described in this chapter.

3.1.**Collection of genotypes**

In the present investigation, six wal genotypes having different growth characters and durationwere collected from Agricultural Botany Research Farm, Department of Agricultural Botany, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli and used for physiological behaviour study under moisture stress condition.

3.2 **Climate and weather conditions**

The agricultural Botany Research Farm comes under the Dapoli taluka, which is situated 240 meterabove mean sea level.Its geological position on world map is 17°74'73.94"N, 73°18'86.07"E. The minimum and maximum temperature and annual rainfall of this placeis26.1 to 32.5 ^{O}C and 3938 mm respectively.

3.3 **Experimental design**

The experiment was laid out in spilt plot design with three replication, provided with eight main treatments (moisture stress level) and six sub treatments (six different genotypes of wal).

3.3.1 **Experimental details**

Crop : Wal (*Lablab purpureus*)

No. of Replication :3

Plot size: 3.7×1.5m=5.55m^2

Spacing : 30 cm x 15 cm

3.3.2**Treatment details**

a) Main plot treatment: 8(moisture stress levels)

I_0: No irrigation after 30 DAS

I_1: One irrigation after 30 DAS

I_2: Two irrigations at 10 days interval

I_3: Three irrigations at 10 days interval

I_4: Four irrigations at 10 days interval

I_5: Five irrigations at 10 days interval

I_6: Six irrigation at 10 days interval

I_7: Seven irrigations at 10 days interval

b) Sub plot treatment: 6(Genotypes)

G_1:No.30

G_2: No.33

G_3: No.54

G_4: No.48

G_5: No.64

G_6: Kokan Wal-2 (check)

3.4 **Cultural practices**

3.4.1 **Field preparation**

The field was prepared by criss-cross ploughing and harrowing.The experiment was conducted at normal fertility level of lateritic soil. Farm yard manure @10 tons/ha was incorporated at the time of preparation of land. Fertilizers were applied @ 25 kg N, 50 kg P_2O_5 per hectare respectively at the time of sowing.

3.4.2**Stress treatment**

The experiment comprised of eight different moisture stresslevels. The plot was irrigated regularly upto 30 days after sowing and then the irrigation was planned as per the given treatment details.

3.4.3**Sowing and cultural operations**

Sowing was done on 31st October 2015. About 1-2 seeds were dibbled at each hill to retain only one healthy seedling per hill.Thinning was done ten days aftersowing. Two weeding's were done at 20 days interval after sowing.

3.5 **Growth observations**

For recording the growth observations, five plants were selected randomly in each plot. These five plants were marked by using zinc labels. Following observations were taken in the course of experimentation.

3.5.1**Plant height (cm)**

The height of the plant was measured from bottom level to the highest growing point of main stem with meter scale in centimeter(cm) at 30, 60 and 90 days after sowing.

3.5.2**Number of leaves**

Total number of leaves produced by plant was recorded from the tagged plant by counting all leaves at 30, 60 and 90 days after sowing. Then average was worked out for statistical analysis.

3.5.3 **Days to 50 per cent flowering**

The number of days taken from the date of sowing to the date on which the 50per cent of the population in a plot exhibited 50 per cent anthesis was recorded as days to 50 per cent flowering.

3.5.4 **Days to maturity**

Period required from date of sowing till the physiological maturity was counted in days and taken as days to maturity by each genotypes.

3.6**Growth analysis**

Five plants from each plot were randomly selected and uprooted carefully. Observations were taken at an interval of 30, 60 and 90 DAS. The plants were brought to the laboratory, washed, blotted dry

and separated into stem and leaf. The stem and leaves obtained from five plants were used for further studies

3.6.1**Leaf areaper plant (dm²/plant)**

Leaf area was measured by Licor Li-3000 C digital leaf area meter in cm^2, then by multiplying with total number of leaves of a plant average leaf area of plant was calculated and expressed in (dm^2/plant).

3.6.2**Leaf area index**

Leaf area index was determined by taking a statistically significant sample of foliage from a plant canopy, measuring the leaf area per sample plot and dividing it by the plot land surface area.Leaf area index (LAI) was calculated as per the formula given by Watson (1958).

$$LAI = \frac{\text{Leaf area per plant}}{\text{Occupied land area per plant}}$$

3.7 **Dry matter studies**

For dry matter studies, five plants were selected randomly at each sampling and were separated into stem and leaves (except first sampling). These were properly labelled and dried in a hot air oven at 80^0C for first one hour and then at constant temperature of 60^0 C. When plant parts were completely dried, the dry weight was recorded separately for each part *i.e.* stem, leaves and roots. Summing up the weight of the stem and leaves of the same plant gave the total dry matter per plant. Percentage distribution of dry matter in different plant parts *i.e.* stem, leaves and roots was calculated by considering total dry matter as 100 percent.

Periodical data obtained from dry matter studies was used for computing the following growth rates.

3.7.1**Absolute growth rate (AGR)**

AGR was calculated from total dry matter accumulation by using formula given by Watson (1958), and expressed as g/day.

$$AGR = \frac{(W_2 - W_1)}{(t_2 - t_1)}$$

Where, W_2 and W_1 represent total dry matter per plant at t_1 and t_2 time intervals respectively.

3.7.2**Relative growth rate (RGR)**

It is the rate of increase in dry weight per unit dry material present per unit time and expressed as g/g/day. RGR was calculated by the formula given by Briggs *et.al* (1920).

$$RGR = \frac{(Log_e W_2 - Log_e W_1)}{(t_2 - t_1)}$$

Where, W_2 and W_1 represent total dry matter per plant at t_2 and t_1 times, respectively.

3.7.3 **Net assimilation rate (NAR)**

The relationship between leaf area and dry matter accumulation was measured with the help of net assimilation rate and it was calculated by the formula as suggested by Gregory (1926) andexpressed as g/dm^2/day.

$$NAR = \frac{(W_2 - W_1)}{(L_2 - L_1)} \mathbf{x} \frac{(Log_e L_2 - Log_e L_1)}{(t_2 - t_1)}$$

Where, W_2 and W_1 represent total dry matter per plant and L_2 and L_1 denote the leaf area per plant at t_2 and t_1 times, respectively.

3.7.4 **Leaf area ratio (LAR)**

Leaf area ratio was worked out by formula given byRadforad (1967) and expressed as dm^2/g/day.

$$LAR = \frac{(RGR)}{(NAR)}$$

3.7.5 **Leaf area duration:**

Leaf Area Duration (LAD) is the ratio of total upper leaf surface of vegetation divided by the surface area of the land on which the vegetation grows at a given period of time and is expressed in days.

$$\text{LAD} = \frac{LAI_1 + LAI_2 (T_2 - T_1)}{2}$$

3.7.6 **Harvest Index (H.I):**

Harvest index of all the genotypes was calculated by the formula given by Donald (1962).

$$\text{Harvest Inde x (\%)} = \frac{\text{Grain weight per plant}}{\text{Total dry weight per plant at harvest}} \times 100$$

3.8 **Physiological behavior observations**

3.8.1 **Total chlorophyll content of leaves (mg/g):**

The total chlorophyll content of the leaves was calculated by using the formula given by Arnon (1949).

3.8.2 **Proline content (μmol/g):**

Proline content in plants was estimated by the method suggested by Bates (1973).

3.8.3 **Relative water content (RWC):**

Relative water content was estimated by the method suggested by Barrs and Weatherley (1962).

3.8.4**Water potential:**

The leaf water potential was determined with a pressurechamber (ARIMAD 3000). The leafwas inserted into the pressure chamber in such a way that 3-5 cm of the petiole remains outside and slowly air pressure was increased with nitrogen gas flow. The pressure at which xylem sap flow initiated at the cut endwas noted. This reading was taken as water potential of particular leaf.

3.9Yield and yield attributes

Harvesting was done when plants reached to physiological maturity. Five randomly selected plants from each plot were harvested separately and observations on these selected plants were recorded as follows.

a) Pods per plant

b) Grains per pod
c) 100 grain weight(g)
d) Number of branches per plant
e) Yield per plant(g)

3.10Statistical analysis

The data collected were subjected to the statistical analysis for split plot design. The statistical analysis of the data was done by the standard method known as 'Analysis of Variance' described by Panse and Sukhatme (1967). The standard error (SE) of mean and critical difference (CD) at 5 per cent level were worked out, wherever the result were significant.

CHAPTER IV

EXPERIMENTAL RESULTS

The results obtained in the present investigation are presented under the following heads.

4.1 Pattern of vegetative growth and source.

4.2 Pattern of growth rates

4.3 Pattern of physiological behaviour

4.4 Pattern of yield and yield attributing characters

4.1 **Pattern of vegetative growth and source**

4.1.1**Mean plant height (cm)**

The periodical data on influence of moisture stress levels on plant height are given in Table 1 and Fig 1. Significant differences in respect of plant height were obtained at all stages of crop growth except 30 DAS. It is evident from the data that irrespective of genotypes, the plant height progressively increased with the advancing age of the crop. Mean plant heightvalues of all 6 genotypes recorded were 35.09 cm, 74.59 cm and 91.68 cm at 30, 60 and 90 days after sowing respectively.

a)Main effect of moisture stress

At 30 DAS, all the moisture stress treatments showed non-significant variation for the plant height, howeverthe plants under I_0(no irrigation after 30 DAS) had maximum mean height of 35.67 cm.

From 60 DAS, onwards the plants under each of the moisture stress treatments differ significantly in respect of height. The difference in mean plant height due to moisture stress treatments become more and more clear with the advancement in developmental stages of crop. The maximum (80.27 cm) plant height was recorded under I_7 (seven irrigation at10 days interval),whereasit was found minimum (54.67 cm) in treatment I_0(no irrigation after 30 DAS).

Table 1.**Influence of different moisture stress levels on plant height (cm)in lablab genotypes at various phases of plant growth**

30 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	39.17	32.33	34.40	**31.49**	37.06	35.23	34.78	33.30	**34.72**	**F.TEST**	**NS**	**NS**	**NS**
G_2	33.80	35.74	35.58	35.96	33.74	32.52	32.85	36.90	**34.64**	**S.Em.±**	0.20	0.12	0.97
G_3	35.00	34.50	36.09	36.21	33.15	32.46	34.41	36.50	**34.79**	**CD 5%**			
G_4	35.33	**40.27**	39.13	32.47	36.70	34.04	34.05	33.23	**35.65**				
G_5	35.67	36.50	33.00	34.45	34.87	38.17	37.09	36.43	**35.77**				
G_6	35.08	33.67	35.33	36.38	32.18	35.52	35.38	36.34	**34.98**				
MEAN	**35.67**	**35.50**	**35.59**	**34.49**	**34.62**	**34.66**	**34.76**	**35.45**	**35.09**				
60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	56.50	66.43	76.79	76.79	78.23	78.36	73.64	75.38	**72.77**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	**43.83**	52.42	81.04	83.60	84.20	82.30	84.50	84.30	**74.52**	**S.Em.±**	0.17	0.22	1.77
G_3	51.35	68.33	80.54	83.16	83.63	83.77	83.77	84.68	**77.41**	**CD 5%**	0.49	0.62	4.97
G_4	64.17	75.09	84.30	83.60	82.40	83.50	84.69	**84.73**	**80.31**				
G_5	49.67	62.10	71.80	72.01	73.26	74.20	77.64	74.20	**69.36**				
G_6	62.50	71.17	75.21	73.60	74.26	74.80	75.60	78.30	**73.18**				
MEAN	**54.67**	**65.92**	**78.28**	**78.79**	**79.33**	**79.49**	**79.97**	**80.27**	**74.59**				
90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	60.23	76.57	86.29	93.00	96.20	102.32	113.92	114.00	**92.82**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	65.32	81.33	85.28	91.87	96.06	101.26	**121.60**	118.00	**95.09**	**S.Em.±**	0.15	0.21	1.66
G_3	63.46	85.95	86.57	86.90	92.06	102.32	114.39	118.00	**93.71**	**CD 5%**	0.44	0.58	4.67
G_4	68.23	78.66	89.38	92.97	98.56	101.26	114.77	115.60	**94.93**				
G_5	**53.03**	68.34	75.68	80.22	89.23	92.36	98.00	99.20	**82.01**				
G_6	67.16	83.62	78.03	84.60	91.01	101.36	112.36	114.23	**91.55**				

MEAN	**62.91**	**79.08**	**83.54**	**88.26**	**93.85**	**100.15**	**112.51**	**113.17**	**91.68**

The final observation of plant height was recorded at 90 DAS. At this stage, the mean plant height under 8 moisture stress levelwere 62.91,79.08, 83.54, 88.26, 93.85, 100.15, 112.51 and 113.17 cm respectively which indicated that there was significant increase in the plant height. The maximum (113.17 cm) plant height was recorded under I_7 (seven irrigation at10 days interval), which was found significantly superior over rest of the treatments. However plant height was found minimum (62.91 cm) in treatment I_0(no irrigation after 30 DAS).

b) Genotype differences

The genotypic difference in plant height started becoming clear from 60 DAS under all moisture stress levels. At 60 and 90 DAS significant difference was observed in plant height among the genotypes. Genotype G_2 (line no. 33), was taller than rest of thegenotypesused for the study purpose.

At 30 DAS all the genotypes were found non-significant for the plant height, however the mean plant height was found to be highest in genotype G_5 (35.77 cm).

At 60 DAS, the maximum height was observed in genotype G_4 (80.31 cm) followed by G_3(77.41 cm). The lowest height was recorded in genotype G_5 (69.36 cm).

At 90 DAS, the maximum height was observed in genotype G_2 (95.09 cm) followed by G_4 (94.93 cm). The lowest height was recorded in genotype G_5 (82.01 cm).

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found significant at all growth stages.

At 30 DAS, the mean plant height was found to be highest in I_1G_4(40.27 cm), followed by I_0G_1(39.17 cm), I_2G_4 (39.13 cm) and

I_5G_5(38.17 cm), which were at par with each other. The lowest height was recorded in I_3G_1 (31.49 cm).

At 60 DAS, the mean plant height was found to be highest in I_7G_4 (84.73 cm), followed by I_6G_4(84.69 cm), I_7G_3(84.68 cm) and I_6G_2 (84.50 cm), which were at par with each other. The lowest height was recorded in I_0G_2 (43.83 cm).

At 90 DAS, the mean plant height was found to be highest in I_6G_2 (121.60 cm), which was at par with I_7G_2 (118.0 cm) and I_7G_3 (118.00 cm). The lowest height was recorded in I_0G_5(53.03 cm).

4.1.2Mean number of leaves.

The periodical data on influence of moisture stress levels on number of leaves per plant are given in Table 2 and Fig 2. Significant differences in respect of number of leaves per plant were obtained at all stages of crop growth *i.e.* 30, 60 and 90 days after sowing (DAS). It is evident from the data that irrespective of genotypes, the number of leaves progressively increased with the advancing age of the crop. Mean values of all 6 genotypes recorded were 5.43, 18.21 and 22.77 at 30, 60 and 90 days after sowing respectively.

a)Main effect of moisture stress

At 30 DAS, all the moisture stress treatments showed non-significant variation for the number of leaves, however the plants under I_5 (five irrigations at 10 days interval) had maximum mean number of leaves of 5.46.

From 60 DAS, onwards the plants under each of the moisture stress treatments differ significantly in respect of number of leaves. Maximum (31.80) number of leaves was recorded under I_7 (seven irrigation at10 days interval), whereas it was found to be minimum (9.20) in treatment I_0(no irrigation after 30 DAS).

Table 2.**Influence of different moisture stress levels on number of leaves in lablab genotypes at various phasesof plant growth**

30 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	5.34	5.35	5.53	5.51	5.31	5.41	5.50	5.28	**5.40**	**F.TEST**	**NS**	**NS**	**NS**
G_2	5.42	5.40	5.33	5.37	5.36	5.31	5.39	5.32	**5.36**	**S.Em.±**	0.03	0.01	0.12
G_3	5.57	5.55	5.34	5.35	5.50	5.51	5.45	5.45	**5.46**	**CD 5%**			
G_4	5.33	5.40	5.40	5.40	5.50	5.41	5.57	5.51	**5.44**				
G_5	5.37	5.45	5.33	**5.27**	5.52	5.53	5.52	5.56	**5.44**				
G_6	5.37	5.45	5.28	5.47	5.40	**5.58**	5.55	5.42	**5.44**				
MEAN	**5.40**	**5.43**	**5.37**	**5.39**	**5.43**	**5.46**	**5.50**	**5.42**	**5.43**				
60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	8.82	10.03	14.52	17.06	19.35	20.16	23.10	32.21	**18.16**	**F.TEST**	**SIG**	**NS**	**SIG**
G_2	10.17	11.85	15.00	16.48	18.48	19.28	22.49	**33.02**	**18.35**	**S.Em.±**	0.14	0.08	0.65
G_3	8.39	9.27	15.04	17.22	19.54	21.88	23.77	30.42	**18.19**	**CD 5%**	0.39		1.84
G_4	9.78	11.28	13.80	17.10	19.35	20.30	22.44	31.92	**18.25**				
G_5	9.67	10.61	13.68	17.02	18.92	20.55	24.35	30.36	**18.14**				
G_6	**8.38**	9.37	13.88	16.82	18.71	21.03	24.15	32.84	**18.15**				
MEAN	**9.20**	**10.40**	**14.32**	**16.95**	**19.06**	**20.53**	**23.38**	**31.80**	**18.21**				
90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	10.12	12.81	16.47	20.88	22.35	25.89	32.84	39.02	**22.55**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	10.58	13.23	18.02	22.07	24.71	28.53	32.58	38.76	**23.56**	**S.Em.±**	0.05	0.04	0.30
G_3	9.16	11.75	17.35	20.90	22.31	27.02	33.45	**39.63**	**22.70**	**CD 5%**	0.14	0.10	0.83
G_4	9.25	11.10	17.05	21.97	23.65	27.59	32.91	39.08	**22.82**				
G_5	9.42	11.72	17.06	21.36	22.98	26.87	32.01	38.19	**22.45**				
G_6	**10.08**	12.81	16.93	20.38	23.82	26.97	31.53	37.70	**22.53**				
MEAN	**9.77**	**12.24**	**17.15**	**21.26**	**23.30**	**27.14**	**32.56**	**38.73**	**22.77**				

At 90 DAS, the mean number of leaves under 8 moisture stress levelwere 9.77, 12.24, 17.15, 21.26, 23.30, 27.14, 32.56 and 38.73, respectively.Maximum (38.73) number of leaves was recorded under I_7 (seven irrigation at10 days interval), however it was found minimum (9.77) in treatment I_0(no irrigation after 30 DAS).

b) Genotype differences

The genotypic difference in number of leaves started becoming clear from 90 DAS under all moisture stress levels. At 90 DAS significant difference was observed in number of leaves among the genotypes. Genotype G_2 (line no. 33), had more number of leaves than all other genotypes used for the investigation.

At 30 DAS, the maximum mean number of leaves were found to be highest in genotype G_3(5.46), followed by G_4, G_5 and G_6 (5.44). The lowest number of leaves was recorded in genotype G_2(5.36).

At 60 DAS all the genotypes were found non-significant for the number of leaves, however the maximum number of leaves were observed in genotype G_2 (18.35).

At 90 DAS, the maximum number of leaves were observed in genotype G_2 (23.56), which was found significantly superior over rest of the genotypes. The lowest number of leaves were recorded in genotype G_5 (22.45).

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found significant at all growth stages.

At 30 DAS, the mean number of leaves were found to be highest in I_0G_2 (6.49), followed by I_1G_2 (6.40), I_7G_2 (6.32) and I_7G_4 (6.08), which were at par with each other. The lowest number of leaves were recorded in I_2G_5 (4.00).

At 60 DAS, the mean number of leaves were found to be highest in I_7G_2 (33.02), followed by I_7G_6 (32.84), I_7G_1 (32.21) and I_7G_4

(31.92), which were at par with each other. The lowest number of leaves were recorded in I_0G_6 (8.38).

At 90 DAS, the mean number of leaves were found to be highest in I_7G_3 (39.63) followed by I_7G_4 (39.08) and I_7G_1 (39.02) which were at par with each other. The lowest number of leaves were recorded in I_0G_6 (10.06).

4.1.3**Fifty per cent flowering**

The data on influence ofmoisture stress levels on 50 % flowering in wal are given in Table 3 and Fig 3. Mean value of all 6 genotypes recorded for 50 per cent flowering was 58.90 days.

a) Main effect of moisture stress

In case of 50 per cent flowering, all the moisture stress treatments showed significant variation. The plants under I_0 (no irrigation after 30 DAS) recorded minimum (54.33 days) for 50 per cent flowering, whereas the maximum (67.11 days) 50 per cent flowering was recorded in I_7 (seven irrigations at 10 days interval). The mean number of days required for 50 per cent flowering under 8 moisture stress levelwere 54.33, 58.39, 62.67, 64.22, 65.94, 66.78, 66.94 and 67.11 daysrespectively.

b) Genotype differences

In case of 50 per cent flowering, significant variation among the genotypes was observed.Genotype G_1 (line no. 30), had minimum number of days for 50 per cent flowering than all other genotypes used for the study purpose.

The mean number of days required for 50 per cent flowering were found to be minimum in genotype G_1(61.50 days,) followed by G_4 (62.21 days). The maximum days for 50 per cent flowering was recorded in genotype G_6(64.46 days).

Table 3.**Influence of different moisture stress levels on 50 per cent flowering (days)in lablab genotypes**

50% FLOWERING (days)													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	**52.67**	56.00	60.67	62.33	64.33	65.00	65.33	65.67	**61.50**	**F.TEST**	**SIG**	**SIG**	**NS**
G_2	54.33	59.33	63.33	65.33	66.67	66.67	66.67	67.33	63.71	**S.Em.±**	0.05	0.06	0.44
G_3	54.00	59.67	64.00	64.00	66.33	68.00	67.67	67.67	63.92	**CD 5%**	0.15	0.16	1.25
G_4	55.67	58.00	62.00	62.67	63.00	65.00	65.67	65.67	62.21				
G_5	54.33	58.33	63.00	65.00	68.33	67.67	67.67	67.67	64.00				
G_6	55.00	59.00	63.00	66.00	67.00	68.33	**68.67**	**68.67**	**64.46**				
MEAN	**54.33**	58.39	62.67	64.22	65.94	66.78	66.94	**67.11**					

c) Interaction effect

Interaction effect between different moisture stress level and genotypes were found to be significant for 50 per cent flowering. The mean number of days required for and 50 per cent flowering were found to be minimum in I_0G_1(52.67 days), whereas the maximum days (68.67) were recorded in I_6G_6 andI_7G_6.

4.1.4**Days to maturity**

The periodical data on influence of moisture stress levels on days to maturity are given in Table 4 and Fig 4. Significant differences in respect of days to maturity were observed during the experiment.Mean values of all 6 genotypes recorded for days to maturity was 99.28 days.

a) Main effect of moisture stress

All the moisture stress treatments had influencesignificant on days to maturity.The plants under I_0 (no irrigation after 30 DAS) recorded minimum (94.60 days) for maturity, whereas the maximum (108.56 days) for maturity was recorded inI_7 (seven irrigations at 10 days interval). The mean number of days required for flower initiation under 8 moisture stress levelwere 94.60,94.97, 95.69, 95.86, 96.74, 103.69, 105.68, and 108.56 days respectively.

b) Genotype differences

In case of maturity non-significant variation among the genotypes was observed, however genotype G_2 (line no.30) had minimum number of days for maturity than all other genotypes tested for the study purpose.

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found to be significant for maturity. The mean number of days required for maturity were found to be minimum

in I_0G_2 (94.12 days), however the maximum (108.87 days) were recorded in I_7G_5.

Table 4.**Influence of different moisture stress levels on days to maturity in lablab genotypes**

Days to maturity (Days)													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	94.29	94.63	95.40	95.77	96.68	103.66	105.57	108.62	**99.33**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	**94.12**	94.43	95.16	95.54	96.48	103.40	105.80	108.36	**99.16**	**S.Em.±**	0.02	0.02	0.18
G_3	94.25	94.59	95.34	95.70	96.57	103.53	105.45	108.52	**99.24**	**CD 5%**	0.06	0.06	0.50
G_4	94.18	94.54	95.24	95.63	97.06	103.95	105.81	108.27	**99.33**				
G_5	96.46	96.88	97.55	96.53	96.90	103.83	105.80	**108.87**	**100.35**				
G_6	94.32	94.74	95.47	95.97	96.79	103.76	105.66	108.74	**99.43**				
MEAN	**94.60**	**94.97**	**95.69**	**95.86**	**96.74**	**103.69**	**105.68**	**108.56**					

4.1.5**Mean leaf area (dm^2/plant).**

The periodical data on influence of moisture stress levels on leaf area are given in Table 5 and Fig 5. Significant differences in respect of leaf area were obtained at all stages of crop growth except 30 DAS. It is evident from the data that irrespective of genotype the leaf area progressively increased with the advancing age of the crop. Mean leaf area values of all 6 genotypes recorded were 2.63dm^2, 62.64dm^2 and 120.37dm^2at 30, 60 and 90 days after sowingrespectively.

a) Main effect of moisture stress

At 30 DAS, all the moisture stress treatments showed non-significant variation for the leaf area, however the plants underI_1 (one irrigation at10 days interval) had maximum mean leaf area of 2.81dm^2.

From 60 DAS, onwards the plants under each of the moisture stress treatments differ significantly in respect of leaf area. Maximum (148.13dm^2) leaf area was recorded under I_7 (seven irrigation at10 days interval), whereas it was found minimum (14.85dm^2) in treatment I_0(no irrigation after 30 DAS).

At 90 DAS, the mean leaf area under 8 moisture stress level were17.57dm^2, 27.65dm^2, 44.01dm^2,75.63dm^2, 109.12dm^2, 151.84dm^2, 224.53dm^2 and 312.63dm^2 respectively.The plants under each of the moisture stress treatments differed significantly in respect of leaf area.Maximum (312.63dm^2) leaf area was recorded under I_7 (seven irrigation at10 days interval) which was found significantly superior over rest of the treatments, whereas itwas found to be minimum (17.57 dm^2) in treatment I_0(no irrigation after 30 DAS).

b) Genotype differences

Significant differences in respect of leaf area was obtained among the genotypes at all the growth stages except 30 DAS. The

Table 5.**Influence of different moisture stress levels on leaf area (dm²/plant) in lablab genotypes at various phases of plant growth**

30 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	2.61	2.77	2.72	2.41	2.55	2.61	2.48	2.24	**2.55**	**F.TEST**	**NS**	**NS**	**NS**
G_2	2.86	2.95	2.66	2.53	2.69	2.52	2.28	2.58	**2.63**	**S.Em.±**	0.02	0.01	0.10
G_3	2.83	2.81	2.38	2.86	2.39	2.74	2.29	2.85	**2.64**	**CD 5%**			
G_4	2.28	2.89	2.38	2.81	2.76	2.86	2.75	2.72	**2.68**				
G_5	2.89	2.63	2.83	2.77	2.40	2.48	2.58	2.51	**2.64**				
G_6	2.83	2.83	2.83	2.39	**2.21**	2.51	**2.98**	2.25	**2.61**				
MEAN	**2.72**	**2.81**	**2.63**	**2.63**	**2.50**	**2.62**	**2.56**	**2.53**	**2.63**				
60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	14.95	19.14	34.97	50.23	57.64	68.18	86.26	159.98	**61.42**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	17.55	28.83	38.53	51.74	65.13	74.45	103.83	**168.05**	**68.51**	**S.Em.±**	0.45	0.22	1.77
G_3	13.62	18.63	32.39	51.26	62.48	81.45	100.17	151.47	**63.94**	**CD 5%**	1.27	0.62	4.97
G_4	13.40	22.63	29.29	53.24	66.47	80.93	98.08	150.14	**64.27**				
G_5	16.49	22.14	35.48	44.40	53.09	61.34	100.48	126.18	**57.45**				
G_6	**13.11**	19.10	36.32	44.82	61.77	77.09	96.67	132.97	**60.23**				
MEAN	**14.85**	**21.75**	**34.50**	**49.28**	**61.10**	**73.91**	**97.58**	**148.13**	**62.64**				
90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	19.01	26.72	45.74	74.92	99.36	139.22	208.44	328.38	**117.72**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	20.17	34.54	49.06	83.47	123.52	167.01	235.29	**333.87**	**130.42**	**S.Em.±**	0.70	0.26	2.09
G_3	16.56	25.64	39.99	75.85	104.03	154.35	228.64	330.27	**122.37**	**CD 5%**	1.97	0.74	5.88
G_4	**14.35**	24.25	38.90	82.52	115.74	165.00	229.79	318.20	**123.60**				
G_5	17.71	26.32	46.91	69.48	98.12	133.80	236.61	282.77	**113.96**				
G_6	17.62	28.41	43.46	67.55	113.93	151.64	208.43	282.34	**114.17**				
MEAN	**17.57**	**27.65**	**44.01**	**75.63**	**109.12**	**151.84**	**224.53**	**312.63**	**120.37**				

genotypic difference in leaf area started becoming clear from the 60DAS under all moisture stress levels.Genotype G_2 (line no.33),had more leaf area than all other genotypes used for the study purpose.

At 30 DAS, the mean leaf area was found to be highest in genotype G_4(2.68dm^2), followed by G_3 (2.64dm^2). The lowest leaf area was recorded in genotype G_1(2.55dm^2).

At 60 DAS, the maximum leaf area was observed in genotype G_2 (68.51dm^2) was found significantly superior over rest of the genotypes. The lowest leaf area was recorded in genotype G_5 (57.45 dm^2).

At 90 DAS, the maximum leaf area were observed in genotype G_2 (130.42dm^2) which was found significantly superior over rest of the genotypes and the minimum leaf area was observed in genotype G_5(113.96dm^2).

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found significant at 60 and 90 DAS.

At 30 DAS, the mean leaf area was found to be highest in I_6G_6 (2.98dm^2).The lowest leaf area was recorded in I_2G_5 (2.13dm^2).

At 60 DAS, the mean leaf area was found to be highest in I_7G_2 (168.05dm^2), followed by I_7G_1(159.98dm^2) and I_7G_3(151.47dm^2). The lowest leaf area was recorded in I_0G_6 (13.11dm^2).

At 90 DAS, the mean leaf area was found to be highest in I_7G_2 (333.87dm^2) followed by I_7G_3(330.27dm^2) and I_7G_1(328.38dm^2)which were at par with each other. The lowest leaf area were recorded in I_0G_4 (14.35dm^2).

4.2 Pattern of growth rates

4.2.1 Mean leaf area index

The periodical data on influence of moisture stress levels on leaf areaindex are given in Table 6 and Fig 6. Significant differences

in respect of leaf area index was obtained at all stages of crop growth except30 DAS. It is evident from the data that irrespective of genotypes, the leaf area index progressively increased with the advancing age of the crop. Mean values of all 6 genotypes recorded were 0.109, 0.685and 0.983at 30, 60 and 90 days after sowing respectively.

a) Main effect of moisture stress

At 30 DAS, all the moisture stress treatments showed significant variation for the leaf area index, the plants underI_1 (one irrigationat 10 days interval) hadmaximum mean leaf area index of 0.115 followed by treatmentI_0 (no irrigation after 30 DAS), whereas it was found minimum (0.105) in treatment I_4(fourirrigations at 10 days interval).

From 60 DAS, onwards the plants under each of the moisture stress treatments differ significantly in respect of leaf area index. The maximum (1.035) leaf area index was recorded under I_7 (seven irrigations at 10 days interval), whereas it was found minimum (0.358) in treatment I_0(no irrigation after 30 DAS).

At 90 DASall the moisture stress treatments showed significant variation for the leaf area index. The mean leaf area index under 8moisture stress levels were0.358, 0.462, 0.536, 0.646, 0.714, 0.800, 0.929 and 1.035 respectively.The maximum (1.035) leaf area index was recorded under I_7 (seven irrigation at10 days interval), whereas it was found minimum (4.89) in treatment I_0(no irrigation after 30 DAS).**b) Genotype differences**

Significant differences in respect of leaf area index was obtained among the genotypes at all the growth stages except 30DAS.The genotypic difference in leaf area index started becoming clear from 60 DAS under all moisture stress levels.Genotype G_2 (line

no.33),had more leaf area index than all other genotypes under investigation.

Table 6.**Influence of different moisture stress levels on leaf area index in lablab genotypes at various phases of plant growth**

30 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.109	0.115	0.123	0.097	0.108	0.108	0.100	0.094	**0.107**	**F.TEST**	**NS**	**NS**	**NS**
G_2	0.117	0.122	0.111	0.104	**0.125**	0.104	0.094	0.108	**0.111**	**S.Em.±**	0.001	0.004	0.003
G_3	0.113	0.112	0.099	0.119	0.097	0.124	0.093	0.116	**0.109**	**CD 5%**			
G_4	0.095	0.120	0.098	0.116	0.111	0.118	0.110	0.110	**0.110**				
G_5	0.119	0.107	0.118	0.117	0.097	0.100	0.120	0.118	**0.112**				
G_6	0.117	0.116	0.119	0.097	0.091	**0.088**	0.120	0.092	**0.105**				
MEAN	**0.112**	**0.115**	**0.111**	**0.108**	**0.105**	**0.107**	**0.106**	**0.106**	**0.109**				
60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.376	0.425	0.535	0.654	0.662	0.752	0.831	1.107	**0.668**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	0.383	0.542	0.571	0.698	0.786	0.859	1.027	**1.131**	**0.750**	**S.Em.±**	0.004	0.002	0.018
G_3	0.362	0.446	0.479	0.662	0.711	0.827	0.937	1.107	**0.691**	**CD 5%**	0.011	0.006	0.051
G_4	**0.305**	0.447	0.472	0.692	0.763	0.887	0.971	1.044	**0.698**				
G_5	0.375	0.460	0.575	0.580	0.624	0.664	0.918	0.923	**0.640**				
G_6	0.349	0.455	0.582	0.593	0.739	0.813	0.889	0.900	**0.665**				
MEAN	**0.358**	**0.462**	**0.536**	**0.646**	**0.714**	**0.800**	**0.929**	**1.035**	**0.685**				
90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.416	0.464	0.617	0.797	0.987	1.195	1.411	1.871	**0.970**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	0.423	0.581	0.606	0.841	1.111	1.301	1.608	**1.895**	**1.046**	**S.Em.±**	0.004	0.002	0.017
G_3	0.402	0.485	0.513	0.804	1.036	1.269	1.517	1.871	**0.987**	**CD 5%**	0.012	0.006	0.048
G_4	**0.345**	0.486	0.507	0.835	1.089	1.329	1.552	1.809	**0.994**				
G_5	0.415	0.500	0.610	0.723	0.949	1.106	1.643	1.645	**0.949**				
G_6	0.389	0.494	0.570	0.735	1.064	1.255	1.470	1.665	**0.955**				
MEAN	**0.398**	**0.502**	**0.570**	**0.789**	**1.039**	**1.243**	**1.533**	**1.793**	**0.983**				

At 30 DAS, the mean leaf area index was found to be highest in genotype G_5(0.112) followed by genotype G_2(0.111).The lowest leaf area index was recorded in genotype G_6(0.105).

At 60 DAS, the maximum leaf area index was observed in genotype G_2 (0.750) and was to be found significantly superior over rest of the genotypes. The lowest leaf area index was recorded in genotype G_5 (0.640).

At 90 DAS, the maximum leaf area index was observed in genotype G_2 (1.046) which was found significantly superior over rest of the genotypes. The minimum leaf area index was recorded in genotype G_5 (0.949).

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found significant at all growth stages.

At 30 DAS, the mean leaf area index was found to be highest in I_4G_2 (0.125).The lowest leaf area index was recorded in I_5G_6 (0.088).

At 60 DAS, the mean leaf area index was found to be highest in I_7G_2 (1.131) which was found significantly superior over rest of the interactions. The lowest leaf area index was recorded in I_0G_4 (0.305).

At 90 DAS, the mean leaf area index was found to be highest in I_7G_2(1.895) followed by I_7G_3(1.871) and I_7G_3(1.871) which were atpar with each other. The lowest leaf area index was recorded in I_0G_4 (0.345).

4.2.2 Mean absolute growth rate (g/day).

The periodical data on influence of moisture stress levels on absolute growth rate are given in Table 7 and Fig 7. Significant differences in respect ofabsolute growth rate were obtained at all stages of crop growth *i.e.* 30-60 and 60-90 days after sowing (DAS).

It is evident from the data that, irrespective of genotype the absolute growth rateprogressively decreased with the advancing age of the

Table 7.**Influence of different moisture stress levels on AGR(g/day) in lablab genotypes at various phases of plantgrowth**

30-60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	1.226	1.490	1.508	1.524	1.580	1.584	1.585	1.612	**1.514**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	1.354	1.459	1.554	1.584	1.643	1.660	1.663	**1.764**	**1.585**	**S.Em.±**	0.002	0.002	0.020
G_3	1.207	1.436	1.544	1.584	1.588	1.589	1.595	1.603	**1.518**	**CD 5%**	0.005	0.007	0.056
G_4	1.283	1.453	1.521	1.572	1.552	1.571	1.585	1.615	**1.519**				
G_5	**1.018**	1.132	1.403	1.456	1.514	1.505	1.563	1.525	**1.389**				
G_6	1.349	1.446	1.491	1.510	1.469	1.537	1.518	1.600	**1.490**				
MEAN	**1.239**	**1.403**	**1.504**	**1.538**	**1.557**	**1.574**	**1.585**	**1.620**	**1.503**				
60-90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.549	0.326	0.582	0.516	0.503	0.540	0.768	0.831	**0.577**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	**0.304**	0.487	0.344	0.516	0.465	0.459	0.771	0.822	**0.521**	**S.Em.±**	0.004	0.004	0.031
G_3	0.610	0.593	0.489	0.512	0.534	0.524	0.752	0.843	**0.607**	**CD 5%**	0.012	0.011	0.088
G_4	0.418	0.576	0.515	0.537	0.573	0.558	0.770	0.836	**0.598**				
G_5	0.547	0.634	0.438	0.570	0.584	0.540	0.777	**0.900**	**0.624**				
G_6	0.307	0.557	0.534	0.455	0.652	0.527	0.829	0.803	**0.583**				
MEAN	**0.456**	**0.529**	**0.484**	**0.518**	**0.552**	**0.525**	**0.778**	**0.839**	**0.585**				

crop. Mean values of all 6 genotypes recorded were 1.503 g/day and 0.839 g/daybetween 30-60 and 60-90 days after sowing respectively.

a) Main effect of moisture stress

From 30-60 DAS as well as from 60-90 DAS, the plants under each of the moisture stress treatments differed significantly in respect of absolute growth rate. The difference in mean absolute growth rate due to moisture stress treatments become more and more clear with the advancement in developmentalstages of crop.

From 30-60 DAS the maximum AGR (1.620 g/day) was recorded in I_7 (seven irrigation at 10 days interval), whereas the minimum AGR (1.239 g/day) was recorded in I_0 (no irrigation after 30 DAS).

From 60-90 DAS, the meanabsolute growth rate under 8 moisture stress level were0.456, 0.529, 0.484, 0.518, 0.552, 0.525, 0.778 and 0.839 g/day respectively. The maximum AGR (0.839 g/day) was recorded in I_7 (seven irrigation at10 days interval), whereas the minimum AGR (0.456g/day) was recorded in I_0 (no irrigation after 30 DAS).

b) Genotype differences

The genotypic difference in absolute growth rate started becoming clear from 30- 60 DAS under all moisture stress levels.Genotype G_2 (line no.33),had more absolute growth rate than all other genotypes used for the study purpose.

Among the genotypes, significant variation with respect to AGR was observed between 30-60 DAS. The maximum absolute growth rate was observed in genotype G_2 (1.585g/day) and was to be found significantly superior over rest of the genotypes. The lowestabsolute growth rate was recorded in genotype G_5 (1.389g/day).

Between 60-90 DAS significant variation with respect to AGR was observed among the genotypes.The maximum absolute growth rate was observed in genotype G_5 (0.624 g/day), whereas the minimum absolute growth rate was recorded in G_2 (0.521 g/day).

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found significant at 30-60 and 60-90 DAS.

Between 30-60 DAS, the mean absolute growth rate was found to be highest in I_7G_2 (1.764g/day) which was significantly superior over rest of the interactions. The lowest absolute growth rate was recorded in I_0G_5 (1.018g/day).

Between 60-90 DAS, the mean absolute growth rate was found to be highest in I_7G_5 (0.900g/day) followed by I_7G_5 (0.900 g/day), I_7G_3 (0.843 g/day), I_7G_4 (0.836 g/day) and I_7G_1 (0.831 g/day).The lowest absolute growth rate was recorded in I_7G_2 (0.304 g/day)

4.2.3 Mean relative growth rate (g/g/day).

The periodical data on influence of moisture stress levels on relative growth rate are given in Table 8 and Fig 8. Significant differences in respect of relative growth rate was obtained at all stages of crop growth *i.e.* 30-60 and 60-90 days after sowing (DAS). It is evident from the data that, irrespective of genotypes the relative growth rate progressively decreased with the advancing age of the crop. Mean values of all 6 genotypes recorded were 0.0704g/g/day and 0.0048g/g/daybetween 30-60 and 60-90 days after sowing respectively.

a) Main effect of moisture stress

From 30-60 DAS and 60-90 DAS, the plants under each of the moisture stress treatments differ significantly in respect of relative growth rate. The difference in mean relative growth rate due to

moisture stress treatments become more and clearer with the advancement in developmental stages of crop.

Table 8.**Influence of different moisture stress levels on RGR(g/g/day) in lablab genotypes at various phases of plant growth**

30-60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.0681	0.0715	0.0701	0.0703	0.0720	0.0711	0.0722	0.0722	**0.0709**	**F.TEST**	**SIG**	**NS**	**NS**
G_2	0.0673	0.0695	0.0693	0.0707	0.0708	0.0704	0.0714	0.0715	**0.0701**	**S.Em.±**	0.0001	0.0001	0.0005
G_3	0.0673	0.0695	0.0705	0.0704	0.0704	0.0717	0.0706	0.0708	**0.0702**	**CD 5%**	0.0003	0.0002	0.0013
G_4	0.0681	0.0707	0.0705	0.0704	0.0705	0.0722	0.0706	0.0709	**0.0705**				
G_5	**0.0646**	0.0670	0.0698	0.0712	0.0712	0.0718	0.0729	0.0722	**0.0701**				
G_6	0.0689	0.0702	0.0712	0.0706	0.0697	0.0712	0.0713	**0.0731**	**0.0708**				
MEAN	**0.0674**	**0.0698**	**0.0702**	**0.0706**	**0.0708**	**0.0714**	**0.0715**	**0.0718**	**0.0704**				
60-90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.0053	0.0041	0.0047	0.0042	0.0040	0.0042	0.0057	0.0060	**0.0048**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	0.0040	0.0042	0.0041	0.0041	0.0036	0.0035	0.0055	0.0055	**0.0043**	**S.Em.±**	0.00002	0.00002	0.00018
G_3	0.0059	0.0050	0.0040	0.0040	0.0042	0.0041	0.0056	0.0061	**0.0048**	**CD 5%**	0.00006	0.00006	0.00052
G_4	0.0040	0.0048	0.0042	0.0042	0.0045	0.0044	0.0057	0.0060	**0.0047**				
G_5	0.0062	0.0064	0.0039	0.0047	0.0047	0.0044	0.0058	**0.0067**	**0.0054**				
G_6	**0.0030**	0.0047	0.0044	0.0038	0.0053	0.0042	0.0063	0.0059	**0.0047**				
MEAN	**0.0047**	**0.0049**	**0.0042**	**0.0042**	**0.0044**	**0.0041**	**0.0058**	**0.0060**	**0.0048**				

From 30-60 DAS the maximum RGR (0.0718g/g/day) was recorded in I_7 (seven irrigations at10 days interval), whereas the minimum RGR (0.0674g/g/day) was recorded in I_0 (no irrigation after 30 DAS).

Between 60-90 DAS, the mean relative growth rate under 8 moisture stress levels were 0.0047, 0.0049, 0.0042, 0.0042, 0.0044, 0.0041, 0.0058 and 0.0060 g/g/day respectively. The maximum RGR (0.0060g/g/day) was recorded in I_7 (seven irrigations at10 days interval), whereas the minimum RGR (0.0041 g/g/day) was recorded inI_5 (five irrigations at10 days interval).

b) Genotype differences

Among the genotypes, non-significant differences were obtained at 30-60 DAS, whereas significant differencesin respect of relative growth rate were obtained at 60-90 days after sowing (DAS).

Between 30-60 DAS, the maximum relative growth rate was observed in genotype G_2 (0.0709 g/g/day).

Between 60-90 DAS, the maximum relative growth ratewas observed in genotype G_5 (0.0054 g/g/day) which was foundsignificantly superior over rest of the genotypes, whereas the minimumrelative growth ratewas observed in genotype G_2 (0.0043 g/g/day)

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes was found to benon-significant at 30-60 DAS, howeversignificant at 60-90 DAS

Between 30-60 DAS, the mean relative growth rate was found to be highest in I_7G_6 (0.0731g/g/day).

Between 60-90 DAS, the mean relative growth rate was found to be highest in I_7G_5 (0.0067g/g/day) followed by I_1G_5 (0.0064g/g/day) and I_6G_6 (0.0063g/g/day) which were at par with

each other.The lowest relative growth rate was recorded in I_0G_6 (0.0030 g/g/day).

4.2.3 Mean net assimilation rate (g/dm^2/day).

The periodical data on influence of moisture stress levels onnet assimilation rate are given in Table 9 and Fig 9. Significant differences in respect of net assimilation rate was obtained at all stages of crop growth *i.e.* 30-60 and 60-90 days after sowing (DAS). It is evident from the data that irrespective of genotype, the net assimilation rate progressively decreased with the advancing age of the crop. Mean values of all 6 genotypes recorded were 0.483g/dm^2/day and 0.079 g/dm^2/dayat 30-60 and 60-90 days after sowing respectively.

a) Main effect of moisture stress

From 30-60 DAS and 60-90 DAS, the plants under each of the moisture stress treatments differ significantly in respect of net assimilation rate. The difference in mean net assimilation rate due to moisture stress treatments become more and more clear with the advancement in developmental stages of crop.

From 30-60 DAS the maximum NAR (0.574 g/dm^2/day) was recorded in I_0 (no irrigation after 30 DAS), whereas the minimum NAR (0.384 g/dm^2/day) was recorded in I_7 (seven irrigations at 10 days interval)

From 60-90 DAS, the mean net assimilation rate under 8 moisture stress levels were 0.123, 0.113, 0.090, 0.070, 0.062, 0.051, 0.063 and 0.059 g/dm^2/day respectively. The maximum NAR (0.123g/dm^2/day) was recorded in I_0 (no irrigation after 30 DAS), whereas the minimum NAR (0.051g/dm^2/day) was recorded inI_5 (five irrigations at10 days interval).

Table 9.**Influence of different moisture stress levels on NAR(g/dm²/day)in lablab genotypes at various phases of plant growth**

30-60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.552	0.610	0.520	0.503	0.503	0.464	0.443	0.380	**0.497**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	0.583	0.502	0.535	0.489	0.443	0.450	0.412	0.392	**0.476**	**S.Em.±**	0.0025	0.0014	0.0116
G_3	0.552	0.573	0.619	0.484	0.498	0.414	0.421	**0.353**	**0.489**	**CD 5%**	0.0070	0.0041	0.0326
G_4	**0.690**	0.567	0.618	0.471	0.442	0.398	0.387	0.377	**0.494**				
G_5	0.443	0.453	0.470	0.487	0.517	0.488	0.361	0.368	**0.448**				
G_6	0.622	0.563	0.495	0.533	0.469	0.461	0.383	0.436	**0.495**				
MEAN	**0.574**	**0.545**	**0.543**	**0.495**	**0.479**	**0.446**	**0.401**	**0.384**	**0.483**				
60-90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.135	0.106	0.098	0.069	0.060	0.055	0.068	0.056	**0.081**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	0.105	0.085	0.084	0.065	0.048	**0.042**	0.057	0.054	**0.067**	**S.Em.±**	0.0006	0.0005	0.0040
G_3	**0.154**	0.123	0.095	0.068	0.060	0.049	0.060	0.056	**0.083**	**CD 5%**	0.0016	0.0014	0.0113
G_4	0.124	0.119	0.102	0.068	0.060	0.049	0.060	0.058	**0.080**				
G_5	0.137	0.128	0.072	0.085	0.073	0.060	0.060	0.070	**0.086**				
G_6	0.082	0.115	0.090	0.066	0.072	0.051	0.069	0.062	**0.076**				
MEAN	**0.123**	**0.113**	**0.090**	**0.070**	**0.062**	**0.051**	**0.063**	**0.059**	**0.079**				

b) Genotype differences

Among the genotypes significant differences in respect of net assimilation rate was obtained at 30-60 and 60-90 days after sowing (DAS).

Between 30-60 DAS, the maximum net assimilation rate was observed in genotype G_1 (0.497 g/dm^2/day) followed by G_6 (0.495 g/dm^2/day), G_4 (0.494 g/dm^2/day) and G_3 (0.489 g/dm^2/day) which were at par with each other. The minimumnet assimilation rate was recorded in genotype G_5 (0.448 g/dm^2/day).

Between 60-90 DAS, the maximum net assimilation ratewas observed in genotype G_5 (0.086 g/dm^2/day) which was found significantly superior over rest of the genotypes.The minimumnet assimilation rate was recorded in genotype G_2 (0.067 g/dm^2/day).

c) Interaction effect

Interaction effect between different moisture stress level and genotypes were found significant at 30-60 and 60-90 DAS.

Between 30-60 DAS, the mean net assimilation rate was found to be highest in I_0G_4 (0.690 g/dm^2/day) which was significantlysuperior over rest of the interactions. The lowest net assimilation rate was recorded in I_7G_3 (0.353 g/dm^2/day)

Between 60-90 DAS, the mean net assimilation rate was found to be highest in I_0G_3 (0.154g/dm^2/day)which was significantly superior over rest of the interactions.The lowest net assimilation rate was recorded in I_5G_2 (0.042 g/dm^2/day).

4.2.4 Mean leaf area ratio (dm^2/g).

The periodical data on influence of moisture stress levels on leaf area ratio are given in Table 10 and Fig 10. Significant differences in respect of leaf area ratio was obtained at all stages of crop growth *i.e.* 30-60 and 60-90 days after sowing (DAS). It is

evident from the data that irrespective of genotypethe leaf area ratio progressively decrease

Table 10.**Influence of different moisture stress levels on LAR(dm²/g) in lablab genotypes at various phases of plant growth**

30-60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.124	0.118	0.135	0.140	0.143	0.154	0.163	0.190	**0.146**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	0.116	0.139	0.130	0.145	0.160	0.157	0.173	0.183	**0.150**	**S.Em.±**	0.0006	0.0004	0.0034
G_3	0.124	0.121	0.114	0.146	0.141	0.173	0.168	0.201	**0.149**	**CD 5%**	0.0018	0.0012	0.0096
G_4	**0.099**	0.126	0.114	0.149	0.160	0.181	0.182	0.189	**0.150**				
G_5	0.147	0.149	0.149	0.146	0.139	0.147	**0.202**	0.197	**0.159**				
G_6	0.113	0.125	0.144	0.133	0.151	0.156	0.187	0.168	**0.147**				
MEAN	**0.120**	**0.130**	**0.131**	**0.143**	**0.149**	**0.161**	**0.179**	**0.188**	**0.150**				
60-90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.040	0.038	0.048	0.061	0.067	0.077	0.084	0.109	**0.065**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	0.038	0.050	0.049	0.063	0.075	0.084	0.095	0.103	**0.070**	**S.Em.±**	0.0003	0.0002	0.0015
G_3	0.038	0.040	0.042	0.060	0.070	0.084	0.092	**0.109**	**0.067**	**CD 5%**	0.0008	0.0005	0.0041
G_4	**0.033**	0.040	0.041	0.062	0.075	0.089	0.095	0.104	**0.067**				
G_5	0.046	0.050	0.055	0.056	0.065	0.073	0.097	0.096	**0.067**				
G_6	0.037	0.041	0.049	0.057	0.075	0.085	0.091	0.094	**0.066**				
MEAN	**0.039**	**0.043**	**0.047**	**0.060**	**0.071**	**0.082**	**0.092**	**0.102**	**0.067**				

with the advancing age of the crop. Mean values of all 6 genotypes recorded were 0.150 dm^2/g and 0.067dm^2/gat 30-60 and 60-90 days after sowing respectively.

a) Main effect of moisture stress

From 30-60 DAS and 60-90 DAS, the plants under each of the moisture stress treatments differ significantly in respect of leaf area ratio. The difference in mean leaf area ratio due to moisture stress treatments become more and more clear with the advancement in developmental stages of crop.

From 30-60 DAS the maximum LAR (0.188dm^2/g) was recorded in I_7 (seven irrigations at 10 days interval), whereas the minimum LAR (0.120 dm^2/g) was recorded in I_0 (no irrigation after 30 DAS).

Between 60-90 DAS, the mean leaf area ratio under 8 moisture stress levels were0.039, 0.043, 0.047, 0.060, 0.071, 0.082, 0.092 and 0.102 dm^2/g respectively. The maximum leaf area ratio (0.102 dm^2/g) was recorded in I_7 (seven irrigations at10 days interval) whereas the minimum(0.039 dm^2/g) was recorded inI_0.

b) Genotype differences

Among the genotypes significant differences in respect of leaf area ratio was obtained at 30-60 and 60-90 days after sowing (DAS).

Between 30-60 DAS, the maximum leaf area ratio was observed in genotype G_5 (0.159dm^2/g) and was to be found significantly superior over rest of the genotypes. The minimumleaf area ratio was recorded in genotype G_1 (0.146dm^2/g).

Between 60- 90 DAS, the maximum leaf area ratiowas observed in genotype G_2 (0.070dm^2/g) which was found significantly superior over rest of the genotypes and the minimumleaf area ratio was recorded in genotype G_1 (0.065dm^2/g).

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found significant at 30-60 and60-90 DAS.

Between 30-60 DAS, the mean leaf area ratio was found to be highest in I_6G_5 (0.202dm^2/g) followed byI_7G_3 (0.201dm^2/g) andI_7G_5 (0.197dm^2/g)which were at par with each other. The lowest leaf area ratio was recorded in I_0G_4 (0.099dm^2/g).

Between 60-90 DAS, the mean leaf area ratio was highest in I_7G_3 (0.109dm^2/g) which was significantly superior over rest of the interactions.The lowest leaf area ratio was recorded in I_0G_4 (0.033 dm^2/g).

4.2.5 Mean leaf area duration (days).

The periodical data on influence of moisture stress levels on leaf area duration are given in Table 11 and Fig 11. Significant differences in respect of leaf area duration was obtained at all stages of crop growth *i.e.* 30, 60 and 90 days after sowing (DAS). It is evident from the data that irrespective of genotypes, the leaf area duration progressively increased with the advancing age of the crop. Meanvalues of all 6 genotypes recorded were 1.64 days, 11.92 days and 25.03 daysat 0-30, 30-60 and 60-90 days after sowing respectively.

a) Main effect of moisture stress

Between 0-30 DAS, all the moisture stress treatments showed significant variation for the leaf area duration, the plants under I_1 (one irrigation at 10 days interval) recorded maximum mean leaf area duration of1.73 days, whereas the plants under I_4(four irrigations at 10 days interval) recorded minimum mean leaf area duration of1.57 days.

From 30-60 DAS, onwards the plants under each of the moisture stress treatments differ significantly in respect of leaf area duration.

Table 11.**Influence of different moisture stress levels on LAD(days) in lablab genotypes at various phases of plant growth**

0-30 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	1.63	1.72	1.84	1.46	1.62	1.62	1.51	1.42	**1.60**	**F.TEST**	**NS**	**NS**	**NS**
G_2	1.76	1.83	1.66	1.56	1.88	1.56	1.41	1.62	**1.66**	**S.Em.±**	0.01	0.01	0.05
G_3	1.69	1.69	1.49	1.78	1.45	1.86	1.40	1.74	**1.64**	**CD 5%**			
G_4	1.42	1.80	1.47	1.74	1.67	1.76	1.64	1.64	**1.64**				
G_5	1.79	1.60	1.77	1.75	1.45	1.50	**2.16**	1.90	**1.74**				
G_6	1.75	1.74	1.79	1.45	1.37	**1.32**	1.80	1.39	**1.58**				
MEAN	**1.67**	**1.73**	**1.67**	**1.62**	**1.57**	**1.60**	**1.65**	**1.62**	**1.64**				
30-60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	7.27	8.09	9.87	11.27	11.55	12.90	13.96	18.02	**11.62**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	7.51	9.96	10.23	12.03	13.67	14.44	16.81	**18.57**	**12.90**	**S.Em.±**	0.06	0.03	0.27
G_3	7.12	8.38	8.66	11.71	12.12	14.27	15.45	18.34	**12.01**	**CD 5%**	0.18	0.10	0.76
G_4	**6.00**	8.50	8.55	12.11	13.12	15.07	16.21	17.31	**12.11**				
G_5	7.42	8.51	10.40	10.45	10.81	11.45	15.93	15.75	**11.34**				
G_6	6.99	8.56	10.52	10.34	12.45	13.51	15.14	14.89	**11.55**				
MEAN	**7.05**	**8.67**	**9.70**	**11.32**	**12.28**	**13.61**	**15.58**	**17.15**	**11.92**				
60-90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG**	**GEN.**	**I X G**
G_1	11.87	13.33	17.28	21.77	24.74	29.21	33.63	44.67	**24.56**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	12.10	16.85	17.65	23.08	28.45	32.39	39.52	**45.38**	**26.93**	**S.Em.±**	0.10	0.06	0.49
G_3	11.46	13.97	14.88	21.99	26.21	31.44	36.81	44.67	**25.18**	**CD 5%**	0.29	0.17	1.37
G_4	**9.74**	13.99	14.69	22.90	27.78	33.24	37.85	42.80	**25.37**				
G_5	11.86	14.40	17.77	19.54	23.59	26.54	38.41	38.53	**23.83**				
G_6	11.07	14.23	17.28	19.92	27.05	31.02	35.39	38.47	**24.30**				
MEAN	**11.35**	**14.46**	**16.59**	**21.53**	**26.30**	**30.64**	**36.93**	**42.42**	**25.03**				

The plants under I_7 (seven irrigations at 10 days interval) recorded maximum mean leaf area duration of17.15 days, whereas the plants underI_0 (no irrigation after 30 DAS) recordedminimum mean leaf area duration of7.05 days.

From 60-90 DAS, the plants under each of the moisture stress treatments differ significantly in respect of leaf area duration. The mean leaf area duration under 8 moisture stress levels were11.35, 14.46, 16.59, 21.53, 26.30, 30.64, 36.93 and 42.42days respectively. The plants under I_7 (seven irrigations at 10 days interval) recorded maximum mean leaf area duration of42.42days, whereas the plants underI_0 (no irrigation after 30 DAS) recordedminimum mean leaf area duration of11.35days.

b) Genotype differences

Among the genotypes significant differences in respect of leaf area durationwas obtained at 0-30, 30-60 and 60-90 days after sowing (DAS).

Between 0-30 DAS, the mean leaf area duration was found to be highest in genotype G_5(1.74days) which was found superior over rest of the genotypes used for the study. The lowest leaf area duration was recorded in genotype G_6(1.58days).

Between 30-60 DAS, the maximum leaf area duration was observed in genotype G_2 (12.90days) and wasfound to be significantly superior over rest of the genotypes. The minimumleaf area duration was recorded in genotype G_5 (11.34days)

At 60-90 DAS, the maximum leaf area durationwas observed in genotype G_2 (26.93days) which was found significantly superior over rest of the genotypes. The minimumleaf area duration was recorded in genotype G_4 (23.83days).

c) Interaction effect

Interaction effect between different moisture stress leveland genotypes were found significant at all growth stages.

Between 0-30 DAS, the mean leaf area duration was found to be highest in I_6G_5 (2.16days) which was significantly superior over rest of the interactions. The lowest leaf area duration was recorded in I_5G_6 (1.32days).

Between 30-60 DAS, the mean leaf area duration was found to be highest in I_7G_2 (18.57 days) which was significantly superior over rest of the interactions. The lowest leaf area duration was recorded in I_0G_4 (6.00days).

Between 60-90 DAS, the mean leaf area duration was found to be highest in I_7G_2 (45.38days) followed byI_7G_1 (44.67days), and I_7G_3 (44.67days). The lowest leaf area duration was recorded in I_0G_4 (9.74)

4.2.6 Mean harvest index (%).

It is observed from Table 12 that the genotypes differ significantly in respect of harvest index. Mean value of all 6 genotypes recorded was 14.04 % as concerned with harvest index.

a) Main effect of moisture stress

The moisture stress levels showed significant variation with respect to harvest index. The mean harvest index under 8 moisture stress levels were10.81, 11.95, 12.90, 13.75, 16.79, 15.96, 15.51 and 14.65 % respectively. Maximum (16.79 %) harvest index was noted in I_4 (four irrigations at an interval of 10 days), whereas the minimum (10.81 %) harvest index was recorded in I_0 (no irrigation after 30 DAS).

b) Genotype differences

The genotypes differ significantly in respect of harvest index. Among the genotypes used for the experiment the maximum harvest indexwas observed in genotype G_2 (15.80 %)which was found

Table 12.**Influence of different moisture stress levels on harvest index(%) in lablab genotypes**

HI													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	9.54	11.95	12.83	13.45	17.81	19.30	14.56	13.96	**14.36**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	14.11	14.54	14.65	15.59	**19.32**	16.82	17.31	15.55	**15.80**	**S.Em.±**	0.10	0.09	0.75
G_3	13.31	13.96	13.26	13.85	19.07	14.72	14.91	15.30	**14.80**	**CD 5%**	0.28	0.26	2.11
G_4	**6.54**	10.85	12.56	14.49	18.28	18.89	19.12	18.34	**14.89**				
G_5	11.98	11.38	11.32	11.19	12.18	12.33	12.82	11.94	**11.89**				
G_6	9.35	9.02	12.77	13.90	14.11	13.71	14.36	12.80	**12.50**				
MEAN	**10.81**	**11.95**	**12.90**	**13.75**	**16.79**	**15.96**	**15.51**	**14.65**	**14.04**				

significantly superior over rest of the genotypes, whereas the minimum harvest index was recorded in G_5 (11.89 %).

c) Interaction effect

Interaction effect between different moisture stress level and genotypes were found significant at all growth stages.

The mean harvest index was found to be highest in I_4G_2 (19.32%) followed by I_5G_1 (19.30%), I_6G_4 (19.12%) and I_4G_3 (19.07%) which were at par with each other. The lowest harvest index was recorded in I_0G_4 (6.54%).

4.3 Pattern of physiological behaviour

4.3.1 TOTAL CHLOROPHYLL (mg/g)

It is observed from Table 13 that at 90 DAS the genotypes differ significantly in respect of total chlorophyll content. Mean value of total chlorophyll content for all six genotypes of wal was recorded2.353 mg/g.

a) Main effect of moisture stress

The plants were influenced significantly by moisture stress levels with respect to total chlorophyll content at 90 DAS. The meantotal chlorophyll content under 8 moisture stress levels were1.770, 2.247, 2.288, 2.321, 2.437, 2.522, 2.556 and 2.261mg/g respectively. The maximum total chlorophyll contentwas observed in treatment I_7 (2.261 mg/g) which was found significantly superior over rest of the treatments, whereas the minimum chlorophyll content was noted in treatment I_0 (1.770 mg/g).

b) Genotype differences

In case of total chlorophyll content significant variation was observed among the genotypes at 90 DAS. The maximum total chlorophyll contentwas observed in genotype G_2 (2.555 mg/ g) which was found significantly superior over rest of the genotypes,

whereas the minimum total chlorophyll content was noted in G_5 (2.096 mg/g).

Table 13. **Influence of different moisture stress levels on total chlorophyll(mg/g) in lablab genotypes**

TOTAL CHLOROPHYLL (mg/g)													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	1.751	2.320	2.216	2.230	2.408	2.419	2.463	2.546	2.294	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	2.022	2.464	2.454	2.521	2.622	2.685	2.741	***2.934***	***2.555***	**S.Em.±**	0.11	0.02	0.12
G_3	1.902	2.299	2.374	2.425	2.569	2.614	2.678	2.761	2.453	**CD 5%**	0.31	0.04	0.34
G_4	1.924	2.443	2.430	2.482	2.605	2.634	2.728	2.811	2.507				
G_5	**1.350**	1.935	2.081	2.053	2.288	2.324	2.337	2.403	**2.096**				
G_6	1.673	2.018	2.170	2.218	2.345	2.454	2.386	2.452	2.215				
MEAN	**1.770**	2.247	2.288	2.321	2.473	2.522	2.556	***2.651***					

c) Interaction effect

At 90 DAS the interaction effect between different moisture stress level and genotypes were found to besignificant.

The mean total chlorophyll content was found to be highest in I_7G_2 (2.934 mg/g) followed by I_7G_4(2.811 mg/g). The lowest total chlorophyll content was recorded in I_0G_5 (1.350 mg/g).

4.3.1aCHLOROPHYLL"a" (mg/g).

It is observed from Table 14 that at 90 DAS the genotypes differ significantly in respect of chlorophyll a content. Mean value of chlorophyll a content for all 6 genotypes of walwas recorded 1.304 mg/g.

a) Main effect of moisture stress

The plants were influenced significantly by moisture stress levels with respect to chlorophyll a content at 90 DAS. The mean chlorophyll a content under 8 moisture stress levels were 0.953, 1.274, 1.300, 1.307, 1.359, 1.381, 1.398 and 1.416mg/g respectively. The maximum chlorophyll a contentwas observed in treatment I_7 (1.416mg/g) which was found significantly superior overrest of the treatments, whereas the minimum chlorophyll a content was noted in treatment I_0 (0.953 mg/g).

b) Genotype differences

In case of chlorophyll a content significant variation was observed among the genotypes at 90 DAS. The maximum chlorophyll a contentwas observed in genotype G_2 (1.441 mg/ g) which was found significantly superior over rest of the genotypes, whereas the minimum chlorophyll a content was noted in G_5 (1.132 mg/g).

c) Interaction effect

At 90 DAS the interaction effect between different moisture stress level and genotypes were found to besignificant.

Table 14.**Influence of different moisture stress levels on chlorophyll(mg/g) in lablab genotypes**

CHLOROPHYLL "a" (mg/g)													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.932	1.325	1.256	1.246	1.314	1.299	1.334	1.391	**1.262**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	1.119	1.424	1.404	1.448	1.461	1.499	1.525	**1.650**	**1.441**	**S.Em.±**	0.11	0.01	0.09
G_3	1.037	1.310	1.355	1.378	1.430	1.441	1.482	1.539	**1.372**	**CD 5%**	0.32	0.03	0.27
G_4	1.052	1.410	1.388	1.429	1.451	1.452	1.517	1.574	**1.409**				
G_5	**0.702**	1.060	1.186	1.102	1.226	1.244	1.247	1.292	**1.132**				
G_6	0.879	1.117	1.212	1.242	1.270	1.353	1.281	1.321	**1.209**				
MEAN	**0.953**	**1.274**	**1.300**	**1.307**	**1.359**	**1.381**	**1.398**	**1.461**	**1.304**				
CHLOROPHYLL "b" (mg/ g)													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	0.818	0.995	0.960	0.984	1.094	1.120	1.129	1.155	**1.032**	**F.TEST**	**SIG**	**SIG**	**NS**
G_2	0.903	1.040	1.050	1.074	1.161	1.186	1.215	**1.284**	**1.114**	**S.Em.±**	0.03	0.01	0.08
G_3	0.866	0.989	1.019	1.048	1.139	1.173	1.196	1.222	**1.081**	**CD 5%**	0.07	0.03	0.21
G_4	0.872	1.033	1.042	1.053	1.154	1.182	1.212	1.237	**1.098**				
G_5	**0.648**	0.876	0.895	0.951	1.063	1.081	1.090	1.111	**0.964**				
G_6	0.794	0.901	0.958	0.976	1.075	1.101	1.105	1.131	**1.005**				
MEAN	**0.817**	**0.972**	**0.987**	**1.014**	**1.114**	**1.140**	**1.158**	**1.190**	**1.049**				

The mean chlorophyll a content was found to be highest in I_7G_2 (1.650 mg/g) followed by I_7G_4(1.574 mg/g). The lowest chlorophyll a content was recorded in I_0G_5 (0.702 mg/g).

4.3.1b CHLOROPHYLL "b" (mg/100 g).

It is observed from Table 14 that at 90 DAS the genotypes differed significantly in respect of chlorophyll b content. Mean value of chlorophyll b content for all 6 genotypes of wal was recorded 1.049 mg/g.

a) Main effect of moisture stress

The plants were influenced significantly by moisture stress levels with respect to chlorophyll b content at 90 DAS. The mean chlorophyll b content under 8 moisture stress levels were 0.817, 0.927, 0.987, 1.014, 1.114, 1.140, 1.158 and 1.190mg/g respectively.

The maximum chlorophyll b contentwas observed in treatment I_7 (1.190 mg/g) which was found significantlysuperior over rest of the treatments, whereas the minimum chlorophyll b content was noted in treatment I_0(0.817 mg/g).

b) Genotype differences

The genotypes differed significantly in respect of chlorophyll b content.

At 90 DAS the maximum chlorophyll b contentwas observed in genotype G_2 (1.114 mg/g) which was found significantly superior over rest of the genotypes, whereas the minimum chlorophyll b content was noted in G_5 (0.964 mg/g).

c) Interaction effect

At 90 DAS the interaction effect between different moisture stress level and genotypes were found to besignificant. The mean chlorophyll b content was found to be highest in I_7G_4 (1.284 mg/g)

which was found significantly superior over rest of the interactions. The lowest chlorophyll b content was recorded in I_0G_5 (0.648 mg/g).

4.3.2PROLINE CONTENT (µmol/g).

It is observed from Table 15 that at 90 DAS the genotypes differed significantly in respect of proline content. Mean value of all 6 genotypes recorded was 4.45µmol/g.

a) Main effect of moisture stress

The plants were influenced significantly by moisture stress levels with respect to proline content at 90 DAS. The mean proline content under 8 moisture stress levels were8.59, 7.12, 4.30, 3.76, 3.41, 3.10, 2.87 and 2.45µmol/g respectively. The maximum proline contentwas observed in treatment I_0 (8.59µmol/g) which was found significantly superior over rest of the treatments, whereas the minimum proline content was noted in treatment I_7 (2.45µmol/g).

b) Genotype differences

The genotypes differed significantly in respect of proline content. At 90 DAS the maximum proline contentwas observed in genotype G_2 (5.29µmol/g) which was found significantly superior over rest of the genotypes, whereas the minimum proline content was noted in genotype G_5 (3.52µmol/g).

c) Interaction effect

At 90 DAS the interaction effect between different moisture stress level and genotypes were found to besignificant. The mean proline content was found to be highest in I_0G_2 (10.66µmol/g) which was found significantly superior over rest ofthe interactions. The lowest proline content was recorded in I_7G_5 (2.17µmol/g).

4.3.3 RELATIVE WATER CONTENT (%).

It is observed from Table 15 that at 90 DAS the genotypes differed significantly in respect of relative water content. Mean value of all 6 genotypes recorded was 77.58%.

Table 15.**Influence of different moisture stress levels on proline(µmol/g)and RWC(%) in lablab genotypes**

PROLINE CONTENT (µmol/g)													
90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	8.20	7.16	4.12	3.79	3.33	3.00	2.61	2.44	**4.33**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	**10.66**	8.36	4.65	4.17	3.97	3.89	3.88	2.73	**5.29**	**S.Em.±**	0.01	0.01	0.05
G_3	9.16	7.87	4.35	3.91	3.50	3.33	2.84	2.52	**4.68**	**CD 5%**	0.03	0.02	0.13
G_4	9.67	7.99	4.87	3.94	3.87	3.33	3.07	2.54	**4.91**				
G_5	6.30	5.40	3.86	3.22	2.56	2.36	2.27	**2.17**	**3.52**				
G_6	7.56	5.95	3.94	3.54	3.24	2.73	2.57	2.34	**3.98**				
MEAN	**8.59**	**7.12**	**4.30**	**3.76**	**3.41**	**3.11**	**2.87**	**2.45**	4.45				
RELATIVE WATER CONTENT (%)													
90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	70.79	74.06	78.24	78.96	79.09	81.49	82.05	82.75	**78.43**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	**60.32**	67.76	72.86	74.15	76.97	74.70	78.28	80.66	**73.21**	**S.Em.±**	0.24	0.14	1.16
G_3	69.85	72.44	72.86	78.37	78.90	81.41	81.89	82.66	**77.30**	**CD 5%**	0.68	0.41	3.25
G_4	65.19	71.46	76.00	77.39	77.82	79.71	81.78	81.83	**76.40**				
G_5	76.72	77.75	78.70	80.83	81.80	83.29	85.87	**87.86**	**81.60**				
G_6	74.15	75.63	78.45	79.08	80.90	83.29	82.38	84.41	**79.79**				
MEAN	**67.84**	**73.18**	**76.18**	**78.13**	**79.24**	**80.65**	**82.04**	**83.36**	77.58				

a) Main effect of moisture stress

The plants were influenced significantly by moisture stress levels with respect to relative water content at 90 DAS. The mean relative water content under 8 moisture stress levelswere67.84, 73.18, 76.18, 78.13, 79.24, 80.65, 82.04 and 83.36 % respectively. The maximum relative water content was recorded in treatment I_7 (83.36 %), whereas minimum was noted in I_0 (67.84 %).

b) Genotype differences

The genotypes differed significantly in respect of relative water content. At 90 DAS the maximum relative contentwas observed in genotype G_5 (81.60 %) which was found significantly superior overrest of the genotypes, whereas minimum relative contentwas observed in genotype G_2 (73.21 %).

c) Interaction effect

At 90 DAS the interaction effect between different moisture stress level and genotypes were found to besignificant. The meanrelative water content was found to be highest in I_7G_5 (87.86 %) which was found to be at par with I_7G_6 (84.41 %). The lowest relative water content was recorded in I_0G_2 (60.32 %).

4.3.4 WATER POTENTIAL (bar).

It is observed from Table 16 that at 90 DAS the genotypes differed significantly in respect of water potential. Mean value of all 6 genotypes recorded was -9.85 bar respectively.

a) Main effect of moisture stress

The plants were influenced significantly by moisture stress levels with respect to water potentialat 90 DAS. The mean water potential under 8 moisture stress levels were -11.01, -10.73, -10.46, -10.08, -9.60, -9.42, -9.04 and -8.48 respectively. The maximum water potential was recorded in treatment I_7 (-8.48 bar), whereas minimum was noted in I_0 (-11.01 bar).

Table 16.**Influence of different moisture stress levels on water potential(bar)in lablab genotypes**

90 DAS												
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	-10.90	-10.63	-10.40	-10.03	-9.57	-9.53	-9.10	-8.63	**-9.85**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	**-12.17**	-11.80	-11.40	-11.23	-10.67	-10.33	-10.13	-9.70	**-10.93**	**S.Em.±**	0.007	0.003	0.027
G_3	-10.77	-10.50	-10.30	-9.90	-9.40	-9.23	-8.67	-8.30	**-9.63**	**CD 5%**	0.019	0.010	0.077
G_4	-10.67	-10.40	-10.10	-9.77	-9.27	-9.03	-8.60	-7.73	**-9.45**				
G_5	-10.50	-10.33	-10.00	-9.37	-9.07	-8.90	-8.53	***-7.70***	**-9.30**				
G_6	-11.07	-10.70	-10.57	-10.17	-9.63	-9.50	-9.23	-8.80	**-9.96**				
MEAN	**-11.01**	**-10.73**	**-10.46**	**-10.08**	**-9.60**	**-9.42**	**-9.04**	**-8.48**	**-9.85**				

b) Genotype differences

The genotypes differed significantly in respect of water potential at 90 DAS. The maximum water potential was observed in genotype G_2 (-10.93 bar) which was found significantly superior over rest of the genotypes, whereas minimum water potentialwas observed in genotype G_5 (-9.30bar).

c) Interaction effect

At 90 DAS the interaction effect between different moisture stress level and genotypes were found to besignificant. The mean water potential was found to be highest in I_7G_5 (-7.70 bar) followed byI_7G_4 (-7.73 bar). The lowest water potentialwas recorded in I_0G_2(-12.17 bar).

4.4 Pattern of yield and yield attributing characters

4.4.1 NUMBER OF BRANCHES.

It is observed from Table 17 that at harvest the genotypes differed significantly in respect of number of branches. Mean value of all 6 genotypes recorded were 3.36 and 4.69 at 60 and 90 DAS respectively.

a) Main effect of moisture stress

At 60 DAS, all the moisture stress treatments showed non-significant variation for the number of branches, however the mean number of branches were found to be highest in I_7 (3.53).

At 90 DAS, all the moisture stress treatments showed significant variation for the number of branches. The mean number of branches was found to be highest in I_7 (5.25) which was significantly superior over rest of the treatments. The lowest number of branches was recorded in I_0 (4.22).

b) Genotype differences

The genotypes differed significantly in respect of number of branches at60 and 90 DAS respectively.

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Table 17. **Influence of different moisture stress levels on number of branches in lablab genotypes at various phases of plant growth**

NUMBER OF BRANCHES													
60 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	3.33	3.83	**4.17**	3.17	3.33	3.83	3.67	4.00	**3.67**	**F.TEST**	**NS**	**SIG**	**SIG**
G_2	3.83	3.67	3.33	3.33	3.17	3.00	3.50	3.50	**3.42**	**S.Em.±**	0.03	0.01	0.10
G_3	3.00	3.17	3.00	3.00	**2.50**	3.00	2.83	3.33	**2.98**	**CD 5%**	0.10	0.03	0.28
G_4	3.83	3.50	3.33	3.33	3.33	3.83	3.00	3.17	**3.42**				
G_5	3.17	3.33	3.00	3.33	3.33	3.00	2.83	3.33	**3.17**				
G_6	3.83	3.17	3.17	3.67	3.83	3.17	3.50	3.83	**3.52**				
MEAN	**3.50**	**3.44**	**3.33**	**3.31**	**3.25**	**3.31**	**3.22**	**3.53**	**3.36**				
90 DAS													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	4.17	4.33	4.83	4.67	4.33	5.00	4.67	5.00	**4.63**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	4.00	4.83	5.17	5.78	4.33	5.00	4.83	**5.83**	**4.97**	**S.Em.±**	0.03	0.02	0.15
G_3	4.67	4.67	5.00	4.33	4.33	4.67	5.00	5.17	**4.73**	**CD 5%**	0.08	0.05	0.43
G_4	4.33	4.33	4.67	4.67	5.33	4.83	5.17	4.50	**4.73**				
G_5	4.17	4.00	4.67	4.00	**3.50**	5.17	4.83	5.67	**4.50**				
G_6	4.00	4.33	4.50	4.67	4.33	4.50	4.83	5.33	**4.56**				
MEAN	**4.22**	**4.42**	**4.81**	**4.69**	**4.36**	**4.86**	**4.89**	**5.25**	**4.69**				

At 60 DAS, the mean number of branches was found to be highest in genotype G_1 (3.67) which was significantly superior over rest of the genotypes. The lowest number of branches was recorded in genotypeG_3 (2.98).

At 90 DAS, the mean number of branches was found to be highest in genotype G_2 (4.97) which was significantly superior over rest of the genotypes. The lowest number of branches was recorded in genotype G_5 (4.50).

c) Interaction effect

The interaction effect between different moisture stress level and genotypes were found to besignificant at 60 and 90 days after sowing.

At 60 DAS, the mean number of branches was found to be highest in I_2G_1 (4.17) which was significantly superior over rest of theinteractions. The lowest number of branches was recorded in I_4G_3 (2.50).

At 90 DAS, the mean number of branches was found to be highest in I_7G_2 (5.83) which was significantly superior over rest of the interactions. The lowest number of branches was recorded in I_4G_5 (3.50)

4.4.2 NUMBER OF PODS PER PLANT.

It is observed from Table 18 that at harvest the genotypes differed significantly in respect of number of pods per plant. Mean value of all 6 genotypes recorded was 17.58.

a) Main effect of moisture stress

At harvest all the moisture stress treatments showed significant variation for the mean number of pods. At harvest the mean number of pods per plantunder 8 moisture stress levels were10.57, 13.56, 14.96, 16.49, 22.20, 21.92, 20.74 and 20.21 respectively.The maximum number of podswere observed intreatment

Table 18.**Influence of different moisture stress levels on number pods per plant in lablab genotypes**

NUMBER OF PODS PER PLANT													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	8.31	10.85	12.95	14.89	19.93	19.91	19.38	18.06	**15.54**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	15.24	17.97	19.40	20.44	**26.58**	25.79	25.23	25.25	**21.99**	**S.Em.±**	0.21	0.08	0.68
G_3	12.28	15.71	16.14	18.38	24.49	23.66	21.88	21.38	**19.24**	**CD 5%**	0.59	0.24	1.91
G_4	12.44	16.20	17.27	19.45	26.05	25.16	22.98	22.57	**20.26**				
G_5	**7.43**	10.04	11.39	12.43	17.66	17.97	16.99	16.83	**13.84**				
G_6	7.69	10.56	12.61	13.37	18.50	19.01	17.95	17.16	**14.61**				
MEAN	**10.57**	**13.56**	**14.96**	**16.49**	**22.20**	**21.92**	**20.74**	**20.21**	**17.58**				

I_4 (22.20) which was found significantly superior over rest of the treatments, whereas minimum number of podswere observed in treatment I_0 (10.57).

b) Genotype differences

At harvestthe genotypes differed significantly in respect of number of pods per plant. The maximum number of pods per plant were observed in genotype G_2 (21.99) which was foundsignificantlysuperior over rest of the genotypes, whereas minimum number of podswere observed in genotype G_5 (13.84).

c) Interaction effect

The interaction effect between different moisture stress level and genotypes were found to besignificant in case of number of pods per plant.The mean number of pods per plant was found to be highest in I_4G_2 (26.58) which was found to be significantly superior over rest of the interactions. The lowest number of pods per plantwas recorded in I_0G_5 (7.43).

4.4.3 SEEDS PER POD.

It is observed from Table 19 that at harvest the genotypes differed significantly in respect of seeds per pod. Mean value of all 6 genotypes recorded was 3.45.

a) Main effect of moisture stress

At harvest all the moisture stress treatments showed significant variation for the seeds per pod. The mean seeds per podunder 8 moisture stress levels were3.06, 3.26, 3.18, 3.43, 3.86, 3.67, 3.66 and 3.46respectively. The maximum seeds per podwere observed in treatment I_4 (3.86) whichwas found significantly superior over rest of the treatments, whereas minimum seeds per podwere observed in treatment I_0 (3.06).

b) Genotype differences

At harvestthe genotypes differed significantly in respect of number of seeds per pod. The maximum seeds per pod were observed in genotype G_2 (3.73) which was found significantly superior over rest of the genotypes, whereas minimum seeds per podwere observed in genotype G_5 (3.02).

c) Interaction effect

The interaction effect between different moisture stress level and genotypes were found to besignificant in case of number of seeds per pod. The mean seeds per pod was found to be highest in I_4G_2 (4.57) which was found to be significantly superior over rest of theinteractions. The lowest number of pods per plantwas recorded in I_0G_5 (2.80).

4.4.4 100 GRAIN WEIGHT (g).

It is observed from Table 19 that at harvest the genotypes differed significantly in respect of 100 grain weight (g). Mean value of all 6 genotypes recorded was 19.77 g.

a) Main effect of moisture stress

At harvest all the moisture stress treatments showed non-significant variation for the 100 grain weight, however the maximum 100 grain weight was observed in treatment I_4 (21.11 g).

b) Genotype differences

At harvestthe genotypes differed significantly in respect of number of 100 grain weight.The maximum 100 grain weight was observed in genotype G_2 (24.43 g) which was found significantly superior over rest of the genotypes, whereas minimum 100 grain weight was observed in genotype G_6 (13.36 g).

Table 19.**Influence of different moisture stress levels on seeds per pod 100 grain weight(g) and seed yield (g) of lablab**

SEEDS PER POD													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	3.07	3.13	3.13	3.40	3.87	3.73	3.67	3.60	**3.45**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	3.07	3.53	3.60	3.67	**4.57**	3.80	3.80	3.80	**3.73**	**S.Em.±**	0.04	0.02	0.19
G_3	3.27	3.33	3.40	3.60	3.73	3.67	3.60	3.60	**3.53**	**CD 5%**	0.11	0.07	0.53
G_4	3.07	3.13	3.03	3.20	4.00	4.23	4.20	3.40	**3.53**				
G_5	**2.80**	2.80	2.80	2.93	3.40	3.20	3.13	3.07	**3.02**				
G_6	3.07	3.60	3.13	3.80	3.57	3.40	3.53	3.27	**3.42**				
MEAN	**3.06**	**3.26**	**3.18**	**3.43**	**3.86**	**3.67**	**3.66**	**3.46**	**3.45**				
100 GRAIN WEIGHT (g)													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	21.96	24.24	22.22	22.37	24.76	24.74	25.50	24.63	**23.68**	**F.TEST**	**NS**	**SIG**	**NS**
G_2	23.81	24.75	25.30	25.26	**25.76**	23.99	22.17	23.59	**24.43**	**S.Em.±**	0.20	0.11	0.90
G_3	16.92	14.78	14.78	17.62	17.02	16.06	15.15	14.48	**16.05**	**CD 5%**		0.32	
G_4	19.31	23.62	24.27	24.33	24.27	23.45	20.17	23.27	**22.77**				
G_5	17.14	21.34	18.84	16.77	21.34	17.00	15.81	14.84	**18.32**				
G_6	**11.92**	13.16	13.16	12.72	13.47	13.40	15.70	16.00	**13.36**				
MEAN	**18.51**	**20.31**	**19.76**	**19.84**	**21.11**	**19.77**	**19.08**	**19.47**	**19.77**				
SEED YIELD (g)													
	I_0	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**	**I_6**	**I_7**	**MEAN**		**IRG.**	**GEN.**	**I X G**
G_1	5.13	7.12	8.08	8.25	13.89	9.88	9.33	12.11	**9.23**	**F.TEST**	**SIG**	**SIG**	**SIG**
G_2	7.66	8.52	9.15	9.82	**14.21**	11.40	11.06	10.73	**10.32**	**S.Em.±**	0.07	0.06	0.47
G_3	7.27	8.54	8.14	8.76	14.06	10.83	9.52	9.39	**9.56**	**CD 5%**	0.18	0.16	1.31
G_4	**3.37**	6.64	7.72	9.21	13.50	13.02	12.29	12.11	**9.73**				
G_5	5.67	6.07	6.28	6.80	8.90	8.42	7.91	7.80	**7.23**				
G_6	4.68	5.48	7.83	8.24	10.21	9.06	8.95	8.79	**7.91**				
MEAN	**5.63**	**7.06**	**7.87**	**8.51**	**12.46**	**10.43**	**9.84**	**10.16**	**9.00**				

c) Interaction effect

The interaction effect between different moisture stress level and genotypes were found to benon-significant in case of 100 grain weight, however mean 100 grain weight was found to be highestin I_4G_2 (25.76 g).

4.1.21 SEED YIELD.

It is observed from Table 19 that at harvest the genotypes differed significantly in respect of seed yield. Mean value of all 6 genotypes recorded was 9.00 g at harvest.

a) Main effect of moisture stress

At harvest all the moisture stress treatments showed significant variation for the seed yield. The mean seed yield was found to be highest in I_4 (12.46 g) which was significantly superior over rest of the treatments. The lowest seed yield was recorded in I_0 (5.63 g).

b) Genotype differences

At harvestthe genotypes differed significantly in respect of seed yield.The mean seed yield was found to be highest in G_2 (10.32 g) which was significantly superior over rest of the genotypes. The lowest seed yield was recorded in G_5 (7.23 g).

c) Interaction effect

The interaction effect between different moisture stress level and genotypes were found to be significant in case of seed yield. The mean seed yield was found to be highest in genotype I_4G_2 (14.21 g) followed by I_4G_3 (14.06 g), I_4G_1 (13.89 g) and I_4G_4 (13.50 g) which were at par with each other. The lowest seed yield was recorded in I_0G_4 (3.37 g).

CHAPTER V
DISCUSSION

Water deficiency is a major factor that reduces the potential productivity of forage plants in the tropics. Different mechanisms contribute to drought resistance in plants. These include the avoidance of plant water deficits by drought escape (short duration), water conservation, and more efficient water uptake (Jones, 1983). More than one of these mechanisms can be used as a defence strategy by plants.

Lablab (*Lablab purpureus* L.)has been noted for decades as being one of the most agro-morphologically diverse and versatile tropical legume species through its roles as pulse (also used as 'dal'), vegetable (green bean, pod, leaf), forage/green manure, herbal medicine, and even ornamental (Adebisi and Bosch 2004).

It is well known fact that lablab has greater developmental plasticity than some of the cultivated legumes which imparts it drought tolerance. Evaluation of such genotypes along with ancestral types under varying soil moisture stress conditions may provide information on crop indices which could be suitably used in quantification of stress in terms of plant parameters such as drought tolerance, high chlorophyll content and high proline content.

In the present investigation, the primary object of this study was to determine the effect of water stress applied at different interval on various stages of growth on yield and physiological parameters of contrasting wal genotypes and to identify the most suitable irrigation interval, where wal genotypes can give maximum returns in terms of yield.

In a view of this, in present studies, genotypes of varied growth were chosen and studied under the following heads

1. Effect of moisture stress level on pattern of vegetative growth and source.
2. Effect of moisture stress le pattern of growth rates
3. Effect of moisture stress levelon pattern of physiological behaviour
4. Effect of moisture stress levelon pattern of yield and yield attributing characters

1. **Effect of moisture stress levelon pattern of vegetative growth and source.**

Plant height (cm)

Plant height is one of the important morphological characters. Plant height is a central part of plant ecological strategy. It is strongly correlated with life span and time to maturity. Plant height is a major determinant of a species ability to compete for light. Plant height is also related to critical ecosystem variables such as carbon storage capacity (Moles *et.al*, 2009).

Plant growth and productivity are primarily dependent on water availability and therefore its decrease has negative effect on plant growth, photosynthesis, solute transport and accumulation. In the present investigation it was observed that the plant height increased with the treatments having less moisture stress.

In the present study plant height increased continuously up to the harvest in all genotypes and moisture stress treatment. The rapid increases in height was observed during initial period of growth and went increasing till 60 DAS and thereafter rate of increase was slow up to the harvest. At 90 DAS the maximum plant height (113.17 cm; 95.09 cm and 121.60 cm respectively) was observed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_2 (line no. 33) and in interaction I_6G_2 (six irrigations at interval of 10 days with line no. 33) respectively. The minimum plant height was noticed in I_0 (no irrigation after 30 days

of sowing) and G_5 (line no. 64). A reason for decrease in plant height as affected by water deficit is reduced cell elongation resulting from decreased turgor, cell volume and cell growth.These results are parallel with the research done by Mwanamwenge*et al.* (1998) in faba bean;Shinde (1998) in lablabMustapha *et al.* (2014) in soybean; Makdul*et.al.* (2011) in soybean; Hasan *et al.* (2014) in lablab; Anita and Lakshmi (2015) in cowpea and Menon and Savitri (2015) in cowpea.

Days to 50% flowering and days to maturity

Early flowering is one of the most desired characters in crops. It determines the period required for start of monitory returns.

The reproductive phase starts with flowering and ends with maturity. In the present investigation it was observed that the days to50% flowering and days to maturity increased with the treatments having less moisture stress.

The minimumdays to 50% flowering(54.33 days; 61.50 days and 52 days respectively) was observed in irrigation treatment I_0 (no irrigation after 30 DAS), genotype G_1 (line no. 30) and in interaction I_0G_1 (no irrigation after 30 DAS with line no. 30) respectively, whereas the minimum days to maturity (94.60 days; 99.16 days and 94.12 days respectively) was observed in irrigation treatment I_0(no irrigation after 30 DAS), genotype G_2 (line no 33) and in interaction I_0G_2 (no irrigation after 30 DAS with line no. 33) respectively.

In the present study the minimumdays to 50% flowering was noticed in I_0 (no irrigation after 30 days of sowing) and G_1(line no. 30), whereas the minimum days to maturity was noticed in I_0 (no irrigation after 30 days of sowing) and G_2 (line no. 33).Early50% flowering and days to maturity in treatments having moisture stress could be attributedto a plants conservation mechanism to reduce water loss from transpiration (Bourgault and Smith 2010)

which shorten the vegetative growth and metabolic assimilates diverted towards the reproductive stage.These results are parallel with the research done byRao (1990) in lablab.

Number of leaves

Leaf is the most important part of the plant. The primary function of the leaf is carbon assimilation and thus, it is the photosynthetic apparatus of the plant. In the present study, it was found that the irrespective of genotypes and stress levels, leaf number increased progressively with the advancing age of crops. Initially the number was rather small but it increased very rapidly during grand growth period of the crop and then towards the maturity, there was little change in the leaf number. In the present investigation it was observed that the number of leaves increased with the treatments having less moisture stress.

The maximum number of leaves (38.73; 23.56 and 39.63 respectively) was observed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_2 (line no 33) and in interaction I_7G_3 (seven irrigations at interval of 10 days with line no. 54) respectively. The minimum number of leaves was noticed in I_0 (no irrigation after 30 days of sowing) and G_6(K.W. 2).This is could be due to fact that water stress leads to decreased in the rate of leaf initiation and reduction in leaf area of already formed leaves. This will result to lower photosynthetic activity in the affected leaves. The overall effect is a decrease in the rate of new leaf initiation and increase in leaf shedding thereby resulting to reduction in number of green leaves per plant. Similar views were also expressed by Rao (1990) in lablab Mwanamwenge*et al.* (1998) in faba bean;Shinde (1998) in lablab Hasan *et al.* (2014) in lablab; Mustapha *et al.* (2014) in soybean and Menon and Savitri (2015) in cowpea.

Leaf area

Leaf area is important in determining the size of the photosynthetic system. More the leaf area more is the scope for absorption of the solar radiation.In the present study, it was found that the irrespective of genotypes and stress levels leaf area increased progressively with the advancing age of crops. With the increasing number of leaves, there was increase in leaf area. In the present investigation it was observed that the leaf area increased with the treatments having less moisture stress. Moistures stress reduced the leaf area in all 6 genotypes

At 90 DAS, the maximum leaf area (312.63dm^2; 130.42dm^2 and 333.87dm^2respectively) was observed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_2 (line no. 33) and in interaction I_7G_2 (seven irrigations at interval of 10 days with line no. 33) respectively. The minimum leaf area was noticed in I_0 (no irrigation after 30 days of sowing) and G_4(line no. 48). A reason for decrease in leaf area as affected by water deficit is that the surface area of leaf is reduced due to loss of turgidity, decrease in the relative water content. Water deficit mostly reduce leaf growth and in turn the leaf area in many plants.These results are parallel with the research done by Rao (1990) and Shinde (1998) in lablab,Kataria and Singh (2014) in mungbean and Mustapha *et al.* (2014) in soybean.

2. **Effect of moisture stress levels on pattern of growth rates**

Leaf area index

Leaf area index is one of the most important growth parameter having influence on plant growth. Leaf area index gives an idea of the size of the photosynthetic system. In the present study, it was found that the irrespective of genotypes and stress levels, leaf area index increased progressively with the advancing age of crops. In

the present investigation it was observed that the leaf area index increased with the treatments having less moisture stress.

At 90 DAS the maximum leaf area index (1.793; 1.046and 1.895 respectively) was observed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_2 (line no. 33) and in interaction I_7G_2 (seven irrigations at interval of 10 days with line no. 33) respectively. The minimum leaf area index was noticed in I_0 (no irrigation after 30 days of sowing) and G_4 (line no. 48). Generally, the leaf area index was reduced among the genotype under high water stress conditions compared to low water stress treatment. This indicated the sensitivity of canopy development to water deficits, which leads to a reduction in leaf area index, resulting from decreased leaf initiation or expansion, an increase in leaf senescence and shedding, or a combination of these processes (Muchow 1985). Additionally, a higher leaf area indexlow water stress conditions may indicate the presence of a greater developmental plasticity leading to enhanced ability to adjust canopy development according to moisture availability (Tesfaye*et al.* 2006).These results are parallel with the research done by Rao (1990) in lablab; Shinde (1998) in lablab;Thiyagarajan*et al.* (2009) in groundnut.

Absolute growth rate

The absolute growth rates are the simplest possible measures of plant growth rate. They can be valuable comparative tools when they are used within like bodies of data.

In the present study, between 60-90 DAS the maximum absolute growth rate (0.839, 0.624 and 0.900g/day respectively) were recorded in I_7 (seven irrigations at interval of 10 days), genotype G_5 (line no. 64) and in interaction I_7G_5 (seven irrigations at interval of 10 days with line no. 64) respectively. This could be due to the rapid rate of increases in total dry matter during this

period as absolute growth rate mainly depends on the accumulation of dry matter. Thereafter, a rapid decreased in absolute growth rateup to the harvest in the subsequent stages was observed in those moisture stress conditions. These results are in accordance with the research done by Rao (1990) in lablab; Parab*et al.* (1991) in cowpea; Mwanamwenge*et al.* (1998) in faba bean;Shinde (1998) in lablab; Hasan *et al.* (2014) in lablab; Hossain and Hossain (2014) in lablab and Mustapha *et al.* (2014) in soybean.

Relative growth rate

For evaluating the efficiency of the existing biomass in producing new biomass, the relative growth rate (RGR) is a valuable parameter. The relative growth rate is usually reduced towards the end of a plant's growth because less leafy biomass is produced, assimilates are transferred towards grain production and ripening, and because net carbon losses occur through respiration of shaded leaf layers. However, a high relative growth rate at the beginning of plants' growth may be especially beneficial under water-limited conditions as high leaf shading on the ground allows the plant to use water that has been evaporated from the soil and reaches the underside of leaves.

In the present study, between 30-60 DAS the maximum relative growth rate(0.0718,0.0709 and 0.0731g/g/dayrespectively) were recorded in I_7 (seven irrigations at interval of 10 days), genotype G_1 (line no. 30) and in interaction I_7G_6(seven irrigations at interval of 10 days with K.W 2) respectively. Between 60-90 DAS the maximum relative growth rate0.0060,0.0054 and0.0067g/g/day) were recorded in I_7 (seven irrigations at interval of 10 days), genotype G_5 (line no. 64) and in interaction I_7G_5 (seven irrigations at interval of 10 days with line no. 64) respectively. These results are similar to those reported by Rao (1990) in lablab;

Parab*et al.* (1991) in cowpea; Mwanamwenge*et al.* (1998) in faba bean;Shinde (1998); Groteluschen (2014),Hasan*et al.* (2014), Hossain and Hossain (2014) in lablab and Mustapha *et al.* (2014) in soybean.

Net assimilation rate

Net assimilation rate is the rate of increases in dry weight per unit leaf area per unit time, which measure the efficiency of leaf. It is an index of productive efficiency of plant or can be range as index of carbon assimilatory capacityof plant. In the present investigation, it was observed that net assimilation rate were higher for the period of 30-60 DAS, later on it decreases. The decreases in net assimilation rate might be due to decreases in photosynthetic efficiency by the early-formed leaves due to senescence, as they grow older.

In the present study, between 30-60 DAS the maximum net assimilation rate (0.574,0.497 and 0.0690g/dm^2/dayrespectively) were recorded in I_0 (no irrigation after 30 DAS), genotype G_1 (line no. 30) and in interaction I_0G_4(no irrigation after 30 DAS with line no. 48) respectively. Between 60-90 DAS the maximum net assimilation rate(0.123, 0.086and 0.154 g/dm^2/dayrespectively) were recorded in I_0 (no irrigations after 30 DAS), genotype G_5 (line no. 64) and in interaction I_0G_3 (no irrigation after 30 DAS with line no. 54) respectively. These results are parallel with the research done by Parab*et al.* (1991) in cowpea; Mwanamwenge*et al.* (1998) in faba bean; Hasan*et al.* (2014), Hossain and Hossain (2014) in lablab and Mustapha *et al.* (2014) in soybean.

Leaf area ratio

Leaf area ratio is the photosynthetic surface area per unit dry weight of a plant. It is a measure of the efficiency with which a plant deploys its photosynthetic resources.

In the present study, between 30-60 DAS the maximum leaf area ratio (0.188,0.159 and 0.202 dm^2/grespectively) were recorded in I_7 (seven irrigation at 10 days interval), genotype G_5 (line no. 64) and in interaction I_6G_5 (six irrigation at 10 days interval with line no. 64) respectively. Between 60-90 DAS the maximum leaf area ratio (0.102, 0.070 and 0.109dm^2/grespectively) were recorded in I_7 (seven irrigations at 10 days interval), genotype G_2 (line no. 33) and in interaction I_7G_3 (seven irrigations at 10 days interval with line no. 54) respectively. These results are parallel with the research done by Parab*et al.* (1991) in cowpea; Mwanamwenge*et al.* (1998) in faba bean; Groteluschen (2014), Hasan*et al.* (2014),Hossain and Hossain (2014) in lablab and Mustapha *et al.* (2014) in soybean.

Leaf area duration

Leaf area duration is the ratio of total upper leaf surface of vegetation divided by the surface area of the land on which the vegetation grows and measured over time. In other words it is the long term relationship of information found from the leaf area index, where the volume of ground cover in relation to upper leaf surface area is measured against time.

In the present investigation, between 0-30 DAS the maximum leaf area duration (1.73, 1.74 and 2.16daysrespectively) was recorded in I_1 (one irrigation after 30 DAS), G_5(line no. 64) and I_6G_5 (six irrigations at 10 days interval with line no. 64) respectively. Between 30-60 DAS the maximum leaf area duration (17.15, 12.90 and 18.57daysrespectively) was recorded inI_7 (seven irrigations at 10 days interval), G_2 (line no. 33) and I_7G_2 (seven irrigations at 10 days interval with line no.33) respectively. Between 60-90 DAS the maximum leaf area duration (42.42, 26.93 and 45.38daysrespectively) I_7 (seven irrigations at 10 days interval), G_2 (line no. 33) and and I_7G_2 (seven irrigations at 10 days interval with line no.33) respectively. These results are parallel with the research

done by Rao (1990) in lablab; Parab*et al.* (1991) in cowpea;Shinde (1998) in lablab; Hossain and Hossain (2014) in lablab and Mustapha *et al.* (2014) in soybean.

3. **Effect of moisture stress levels on pattern of physiological behaviour**

Total chlorophyll content

Chlorophyll plays vital role in the process of photosynthesis, thus having direct influence on plant growth and its metabolic activities. In the present investigation it was observed that the chlorophyll content increased with the treatments having less moisture stress.

At 90 DAS the maximum total chlorophyll content(2.651 mg/g; 2.555 mg/g and 2.934 mg/g respectively) was observed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_2 (line no. 33) and in interaction I_7G_2 (seven irrigations at interval of 10 days with line no. 33) respectively. Whereas the maximum chlorophyll a(1.461 mg/g; 1.441 mg/g and 1.650 mg/g respectively) and chlorophyll b (1.190 mg/g; 1.114 mg/g and 1.284 mg/g respectively) was noticed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_2 (line no. 33) and in interaction I_7G_2 (seven irrigations at interval of 10 days with line no. 48) respectively.

In the present study the minimum total chlorophyll content was noticed in I_0 (no irrigation after 30 days of sowing) and G_5 (line no. 64). A reason for decrease in chlorophyll content as affected by water deficit is that, moisture stress by producing reactive oxygen species (ROS) such as O_2 and H_2O_2 can lead to lipid peroxidation and consequently chlorophyll destruction also, with decreasing chlorophyll content due to the changing green colour of the leaf into yellow, the reflectance of the incident radiation is increased. The decrease in the total chlorophyll content may have resulted

from a decrease in the leaf water status of the plant. These results are parallel with the research done by Shinde (1998) in lablab; Hayatu and Mukhtar (2010) in cowpea; Kumar *et.al.* (2011) in pigeonpea; Makbul*et.al.* (2011) in soybean and Kataria and Singh (2014) in mungbean.

Proline content

A very important role of proline in response to osmotic stress maybe to promote the biosynthesis of cell wall matrix proteins, such as extensin, which has an important role in maintaining cell morphology and provides a mechanical support of plant cells subjected to stress conditions (Nanjo *et al.*, 1999).In the present investigation it was observed that the proline content increased with the treatments having more moisture stress.

At 90 DAS the maximum proline content (8.59µmol/g; 5.29 µmol/g and 10.66µmol/grespectively) was observed in irrigation treatment I_0 (no irrigation after 30 DAS), genotype G_2 (line no. 33) and in interaction I_0G_2 (no irrigation after 30 DAS with line no. 33) respectively. Whereas the minimum proline content was noticed in I_7(no irrigation after 30 days of sowing) and G_5 (line no. 64). A reason for increase in proline content as affected by water deficit could be due tolesser incorporation of continuously synthesized proline amino acid during proline synthesis. The proline proved to be one of the major solutes in drought tolerance. These results are parallel with the research done by Purushottam*et al.,* (1998) in groundnut;Shinde (1998) in lablab;Kala *et al.* (2008) in ber; Kumar *et.al.* (2011) in pigeonpea and Sun *et.al.* , (2015) in strawberry.

Relative water content

Relative water content may be attributed to differences in the ability of the variation to absorb more water from the soil and/or the ability to control water loss through stomata and relative water content parameters can be used to select high yielding genotypes

that maintain cell turgor under water stress environment to give relative high yield. In the present investigation, it was observed that the relative water content increased with the treatments having less moisture stress.

At 90 DAS the maximum relative water content (83.36 %; 81.60 % and 87.86 %respectively) was observed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_5 (line no. 64) and in interaction I_7G_5 (seven irrigations at interval of 10 days with line no. 64) respectively.

In the present study the minimum relative water content was noticed in I_0 (no irrigation after 30 days of sowing) and G_2(line no. 33). A decrease in relative water content as affected by water deficit indicated that theplants have the ability to sustain their water content under mild stress, whereas this ability is lost under severe stress treatment. Similar results were reported byShinde (1998) and Hall and Naidu (2004) in lablab and Kumar *et.al.* (2011) in pigeonpea.

Water potential

Water potential is a direct index to reflect the plant water status or water deficit and can be used to estimate the drought-resistant ability of plants under drought stress (Na *et al.*, 2014). In the present investigation it was observed that the water potentialbecome more negative the treatments having more moisture stress.

At 90 DAS the maximum water potential (-8.48 bar; -9.30 bar and -7.70 barrespectively) was observed in irrigation treatment I_7 (seven irrigations at interval of 10 days), genotype G_2 (line no. 33) and in interaction I_7G_2 (seven irrigations at interval of 10 days with line no. 33) respectively.

In the present study the minimum relative water content was noticed in I_0 (no irrigation after 30 days of sowing) and G_5(line no.

64). A decrease in water potential as affected by water deficit indicated that the wal genotypes have a certain ability to adapt to drought by reducing cellular water potential under water stress, improving their absorption of moisture in the dry environment in soil, thereby improving drought resistance.Similar results were reported by Makbul*et.al.* (2011) in soybean;Chandrasekhar*et al.* (2012) in banana and Sun *et.al,* (2015) in strawberry.

4. Effect of moisture stress levels on pattern of yield and yield attributing characters

Seed yield

Seed yield is the economic part of the total dry matter. This is the end product of the plant life cycle and it is of much interest to mankind. Yield is a compound character and is the sum total of the contribution made by a number of physiological characters. It is the ultimate product of the action and interaction of a number of component of plant characters. To the plant physiologist, it is net economic gain yield from the source and the sink capacity. In the present investigation, the seed yield per plant ranged from 3.37 g to 14.21g with the overall mean of 9.00 g irrespective of moisture stress level and genotypes.In the present study, among the genotypes themaximum (10.32 g) seed yield was recorded in G_2 (line no 33) Genotypes G_2 (line no 33) has showed 33.47 % increment in seed yield over the control irrespective of moisture stress treatments. In case of moisture stress level the maximum (12.46 g) seed yield per plant was recorded in I_4 which is 22.64 % increment over the I_7. These results are parallel with Shinde (1998) in lablab;Ogedegbe*et. al.* (2012)in lablab,Kumar and Singh (2014) in mustard; Mustapha *et al.* (2014) in soybean; Siahbidi*et al.* (2014) in soybean; Anita and Lakshmi (2015) in cowpea and Menon and Savitri (2015) in cowpea.

Harvest index

Although, both the grain and biomass yield are important, grain yield is more important than biomass yield and hence, it is necessary to study the relationship of grain to biomass. This is effectively done by working harvest index. Harvest index is the percentage of biological yield, represented by economic yield. Donald (1962) defined harvest index as, 'the ratio of grain weight to the total dry weight of above ground parts at maturity of the crop'. Partitioning the dry matter into economic and non-economic parts is the interest of the plant scientist, because yield in any crop depends upon its capacity to produce dry matter and its efficient partitioning between economic and non-economic parts. Harvest index helps in knowing how much of the total dry matter is converted into economic part. Higher this conversion, higher will be harvest index and hence, this would help in designing an ideal plant type where more portion of the total dry matter is converted into economic parts.

In the present investigation, it was observed that the harvest index ranged from 10.81 to 14.65 percent. The maximum harvest index (16.79, 15.80 and 19.32 percent respectively) were recorded in I_4 (four irrigations at 10 days interval), genotype G_2 (line no. 33) and in interaction I_4G_2 (four irrigations at 10 days interval with line no. 33) respectively.

The two physiological processes that are closest to final yield expression are net accumulation of photosynthates and the partitioning of photosynthates between grain and other plant organs. This was because of the difference in total dry matter production and hence, it appears that instead of considering the harvest index alone, it would be worthwhile to consider it along with the total dry matter production. Therefore, in any crop improvement programme, an improvement both in biological yield and harvest index alone cause enhancement in the economical

yield.The varietal difference for harvest index in lablab also reported by theRao (1990),Shinde (1998),Groteluschen (2014) and Hasan*et. al.* (2014) in lablab.

CHAPTER VI

SUMMARY AND CONCLUSION

Drought is an important abiotic stress affecting the productivity of all rainfed crops, however, no remarkable progress has been made in this area. The moisture stress is the major constrain for yield in pulses. The performance of the genotypes in terms of productivity is the net result of interaction of genotypes and environment. So far, breeders have made attempts to breed high yielding genotype under rainfed conditions based on only morphological, yield and yield attributing characters. However, drought tolerant trait include morphological, physiological, biophysical and biochemical parameters which have a molecular genetic base. Thus, there is a need to identify drought tolerant traits and cultivars to minimize the reduction in production and productivity of crops.

The present investigation on "Studies on physiological behaviour of Wal (*Lablab purpureus*) genotypes under moisture stress condition" was carried out with six genotypes. The genotypes were grown in spilt plot design with three replication provided with eight main treatments (moisture stress level) and six sub treatments (six different genotypes) at Agricultural Botany Research Farm, Department of Agricultural botany, College of Agriculture, Dapoli during the year 2015-2016. The data on plant height, number of leaves, days to 50 % flowering, days to maturity, leaf area, leaf area index, absolute growth rate, relative growth rate, net assimilation rate, leaf area ratio, leaf area duration, harvest index, total chlorophyll content, proline content, relative water content, water potential, Pods per plant, grains per pod,100 grain weight(g), number of branches per plant and yield per plant(g) were collected in order:

1. To investigate the impact of moisture stress on morpho-physiological traits of wal genotypes.
2. To study the impact of moisture stress on biochemical parameters of wal genotypes.
3. To find out moisture stress tolerant high yielding genotypes of wal.

The results obtained during the present investigation are briefly summarized below.

The mean plant height continuously increased with the advancing age of the crop upto harvest. However plants from I_7(seven irrigations at interval of 10 days) recorded 79.89% higher plant height over the I_0 (no irrigation after 30 DAS). Genotype G_2 (line no. 33) has showed overall 3.87% increase in plant height over G_6 (K.W. 2) or control. Thus under all moisture stress levels G_2 (line no. 33) appeared to be more stress tolerant as far as plant height is concerned as compared to all other genotypes.

The number of leaves progressively increased with the advancing age of the crop, thereby gradually decreased in all the stressed condition. The plants from I_0 (no irrigation after 30 DAS) recorded 68.4 % reduction in the number of leaves over I_7(seven irrigations at interval of 10 days). Genotype G_2 (line no. 33) has showed overall 4.19 % increase in the number of leaves over G_6 (K.W. 2) or control. Thus under all moisture stress levels G_2 (line no. 33)appeared to show less reduction as far as number of leaves is concerned as compared to all other genotypes, indicating the morphologically better performance of the genotype under water stress environment.

The study further revealed that, total leaf area and leaf area index (LAI) progressively increased with the advancing age of the crop. The plants from I_0 (no irrigation after 30 DAS) recorded 94.38% reduction in the leaf area and 94.37%reduction in LAI over

the I_7(seven irrigations at interval of 10 days). Genotype G_2 (line no. 33) has showed overall 14.23% increase in the leaf area over G_6 (K.W. 2) or control. Thus under all moisture stress levels G_2 (line no. 33) appeared to show less reduction as far as leaf area is concerned as compared to all other genotypes, indicating the sustainability of the genotypes more robustly under moisture stress condition.Genotype G_2 (line no. 33) has showed overall 14.23% increase in the leaf area index over G_6 (K.W. 2) or control, indicating the ability of the genotype to withstand under moisture stress condition.

Among the different moisture stress treatments, absolute growth rate (AGR) increased rapidly upto 30-60 DAS and decreased in later growth stages. Amongst the genotypes under eight different water stress conditions studied, genotype G_5 (line no. 64) has showed overall 7.03% increase in the AGR over G_6 (K.W. 2) or control, indicating the sustainability of the genotype more robustly under moisture stress condition.

Amongst the genotypes under eight different water stress conditions studied, genotype G_5 (line no. 64) has showed overall 14.89% increase in the RGR over G_6 (K.W. 2) or control as compared to rest of the genotypes.

In general, mean net assimilation rate (NAR) increased rapidly upto 30-60 DAS and decreased in later growth stages.Amongst the genotypes under eight different water stress conditions studied, genotype G_5 (line no. 64) has showed overall 13.16% increase in the NAR over G_6 (K.W. 2) or control as compared to rest of the genotypes, indicating the higher efficiency of this genotype for maintaining more photosynthetically active tissues at critical stages.

The chlorophyll content show considerable amount of variability at 90 DAS, genotype G_2 (line no. 33) showed 15.35 %

increase in total chlorophyll over genotype G_6 (K.W. 2) or control irrespective of moisture stress treatments. In case of moisture stress treatments, the plants from I_0 (no irrigation after 30 DAS) recorded 33.23 reduction in total chlorophyll over I_7(seven irrigations at interval of 10 days).

The proline accumulation was higher under I_0 (no irrigation after 30 DAS) than that of I_7(seven irrigations at interval of 10 days). Further genotype G_2 (line no. 33) recorded 32.91 % more proline accumulation than that of genotype G_6 (K.W. 2) or control irrespective case of moisture stress treatments.In other words, inherently drought tolerant genotype showed tendency to generate great amount of proline under moisture stress condition. Thus, from the above biochemical studies, it could be inferred that chlorophyll and proline content could be taken as one of the parameters while screening for drought tolerance.

Relative water content and water potential of leaves indicate the actual water content to its maximum turgidity. It was observed that plants under I_7(seven irrigations at interval of 10 days) had maintained higher RWC and water potential over I_0 (no irrigation after 30 DAS). Genotype G_2 (line no. 33) has showed less reduction in RWC and water potential.

Studies of yield and its components indicated significant difference among the six genotypes of wal under different moisture stress level. From the present investigation it is revealed that genotype G_2 (line no. 33) was earliest to flower and maturity and showed less reduction for days to flower and maturity under I_0 (19.30 %, 13.04 % respectively) moisture stress treatments, indicating better performance of this genotype for reproductive attributes.In the present investigation, the seed yield per plant ranged from 7.23 to 10.32 g, the lowest and highest being in G_5 and G_2 respectively, irrespective of moisture stress

treatments.When compared, seed yield recorded due to various moisture stress levels, I_4 *i.e.* four irrigations at 10 days interval after 30 DAS was found most optimum as it recorded higher seed yield than I_5 (five irrigations at 10 days interval), I_6 (six irrigations at 10 days interval) and I_7 (seven irrigations at 10 days interval).

The plants under I_4 (four irrigations at interval of 10 days) recorded higher harvest index (14.61%) over I_7 (seven irrigations at interval of 10 days). Genotype G_2 performed better than other genotypes studied, indicating the ability of genotype to maintain good partitioning ability under different moisture stress condition.

Conclusion:

In conclusion, it is to be stated that a wide range of variability exists for different morpho-physiological and biochemical parameters among six genotypes of wal under different moisture stress conditions. Among the six genotypes of wal studied under different moisture stress conditions, genotype G_2 recorded high yield under I_4 (four irrigation at 10 days interval) moisture stress condition, owing to their high efficiency to produce maximum economical yield.Four irrigations at 10 days interval after 30 days after sowing (I_4) could be considered as the optimum level of irrigation frequency for higher yield with saving in water.This information may be helpful for better understanding of concept of critical stages of vegetative and reproductive growth and its application to the effect of drought at various aspects of growth and yield of wal. It can be employed for the improvement programme as well as efficient management practices for wal production in drought prone areas.

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APPENDIX I

Meteorological data of the crop season *Rabi*, 2015-16

MW	Period (29.10.2015 to 11.02.2016)	Temperature (^{0}C)		Mean relative humidity (%)		Wind Speed (Km /hr)	Evap. (mm/ day)	Sun-shine (hrs^{-1})
		Max.	Min.	Morn.	Even.			
44	29.10-04.11	32.8	21.3	90	52	2.5	4.3	6.8
45	05.11-11.11	33.8	20.3	91	52	2.6	4.2	6.9
46	12.11-18.11	34.2	17.3	93	42	2.5	3.9	8.2
47	19.11-25.11	32.9	20.6	90	52	3.2	3.5	6.0
48	26.11-02.12	33.4	19.2	93.7	47.1	2.6	3.2	6.9
49	03.12-03.12	34.0	16.9	94	41	3.0	3.8	7.6
50	10.12-16.12	32.7	17.1	95	50	2.7	3.4	8.1
51	17.12-23.12	31.8	15.6	94	49	3.0	3.5	7.9
52	24.12-31.12	32.1	11.4	84	29	3.0	3.8	8.4
1	01.01-07.01	34.1	12.7	93	30	2.6	3.5	8.3
2	08.01-14.01	32.4	12.9	95	41	2.8	2.9	7.6
3	15.01-21.01	28.9	11.9	94	39	3.6	3.3	8.5
4	22.01-28.01	32.0	12.4	82	36	3.8	4.0	8.4
5	29.01-04.02	34.7	12.5	92	38	3.1	4.2	8.5
6	05.02-11.02	29.2	13.0	93	56	3.8	3.7	8.1
Mean/Total		32.6	15.3	91.7	43	2.61	3.64	7.8

APPENDIX II

Abbreviations used

et al.	and others
%	Percent
°C	Degree Celsius
µmol/m^2/s	micro mole per square meter per second
AGR	Absolute growth rate
cm	Centimeter
cm^2	Centimeter square
CPE	Cumulative pan evaporation
DAS	Days after sowing
dm^2	Decimeter square
dm^2/g	Decimeter square per gram
etc	Et cetera
i.e.	That is
Fig	Figure
g/day	Gram per day
g/dm^2/day	Gram per decimeter square per day
g/g/day	Gram per gram per day
g or gm	Gram
H.I	Harvest index
ha	Hectare
IW	Irrigation water
kg	Kilogram
LAD	Leaf Area Duration
LAI	Leaf area index
LAR	Leaf area ratio
m^2	Meter square
mg	Milligram
mm	Millimeter
MPa	Mega pascal
MPI	Mean productivity Index
MSI	Moisture Stress Intensity
MST	Moisture Stress Tolerance
NAR	Net assimilation rate
RGR	Relative growth rate
t	Ton
viz.	Namely
WAS	Weeks after sowing
µmol/g	micro mole per gram
mg g^{-1}	Milligram per gram
K.W. 2	Kokanwal 2

Affectionately Dedicated
To My Greatest loss

Late. Mr. Shrikant Kamat

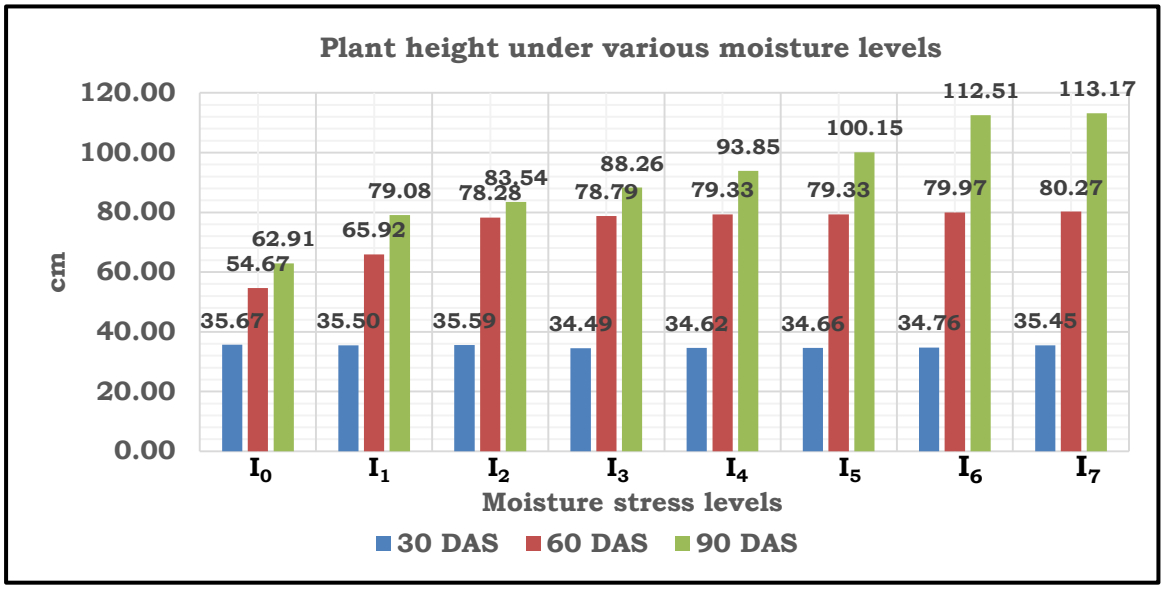
Late. Mr. Gururama Lotlikar

Late. Shrimati Anandibai Lotlikar

and

Late Mr. Prabhakar Raikar

Fig.1 Mean plant height (cm) of six wal genotypes at various phases under different degree of moisture stress



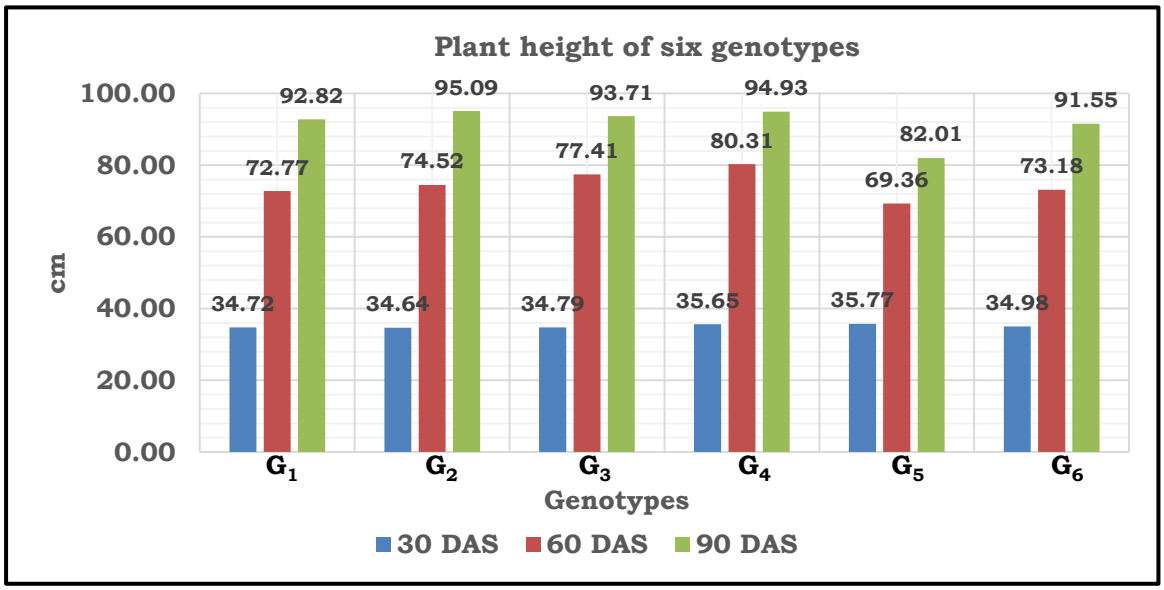
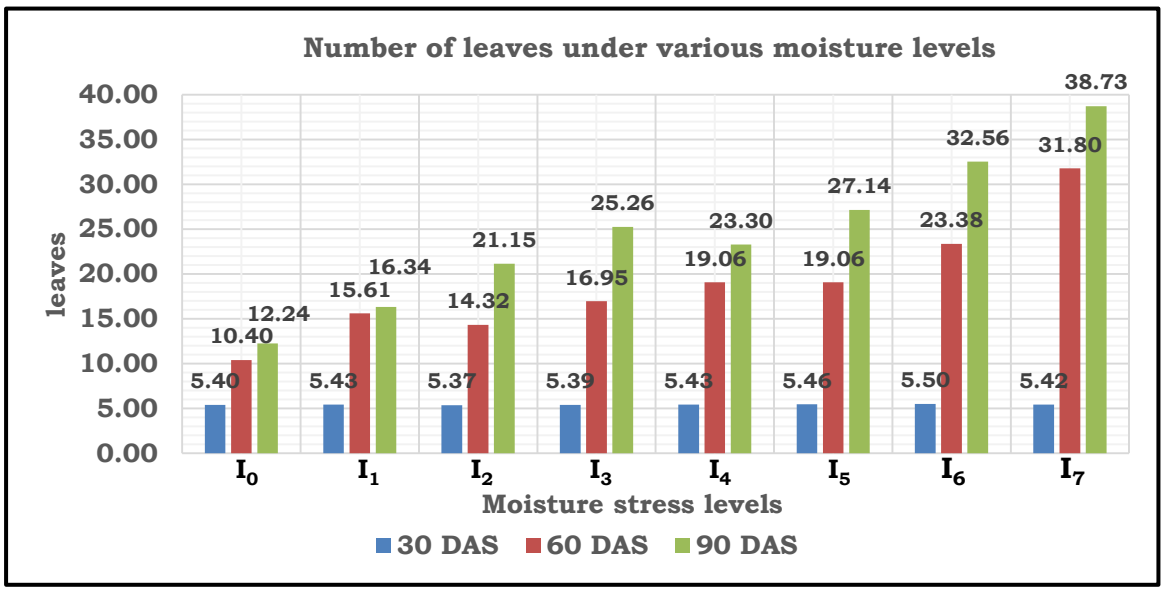


Fig.2 Mean number of leaves of six wal genotypes at various phases under different degree of moisture stress



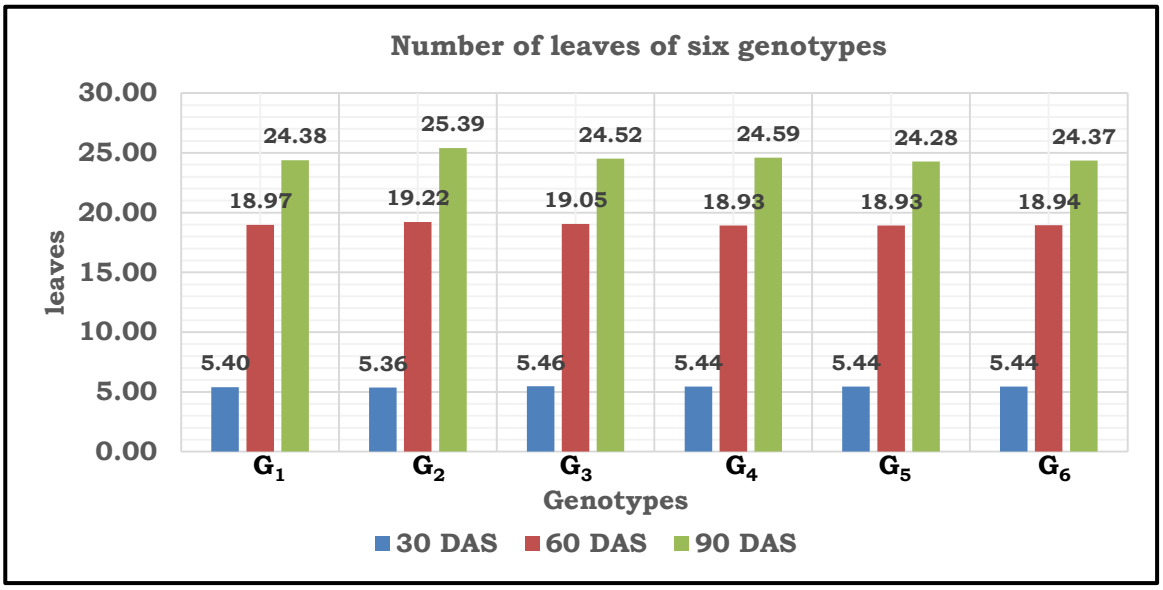
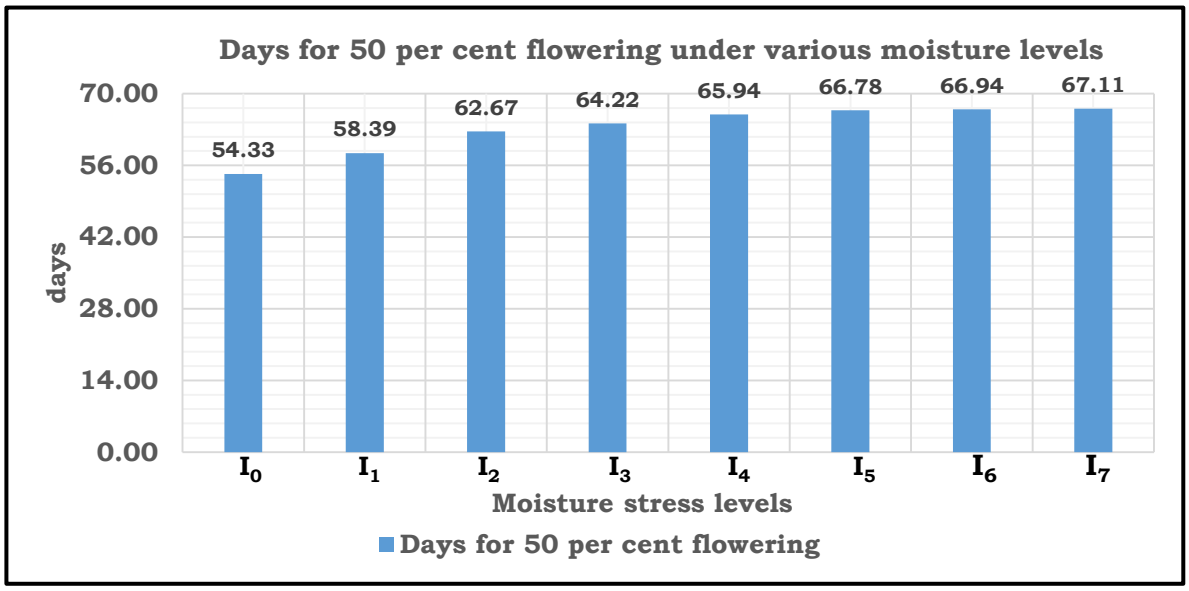


Fig.3 Mean days for 50 % flowering in six wal genotypes at various phases under different degree of moisture stress



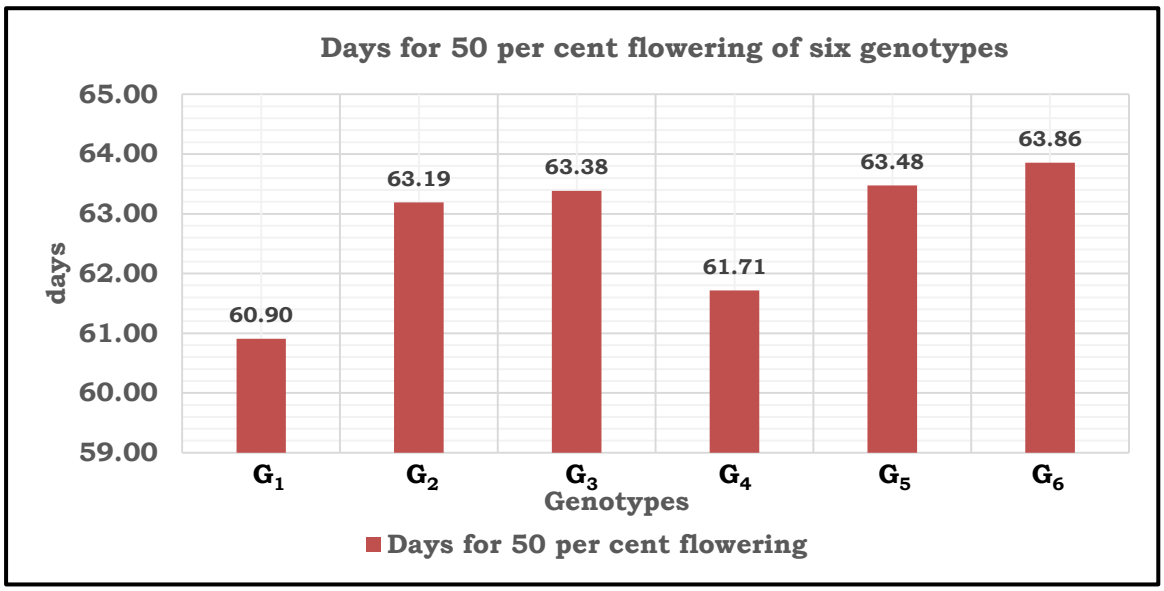
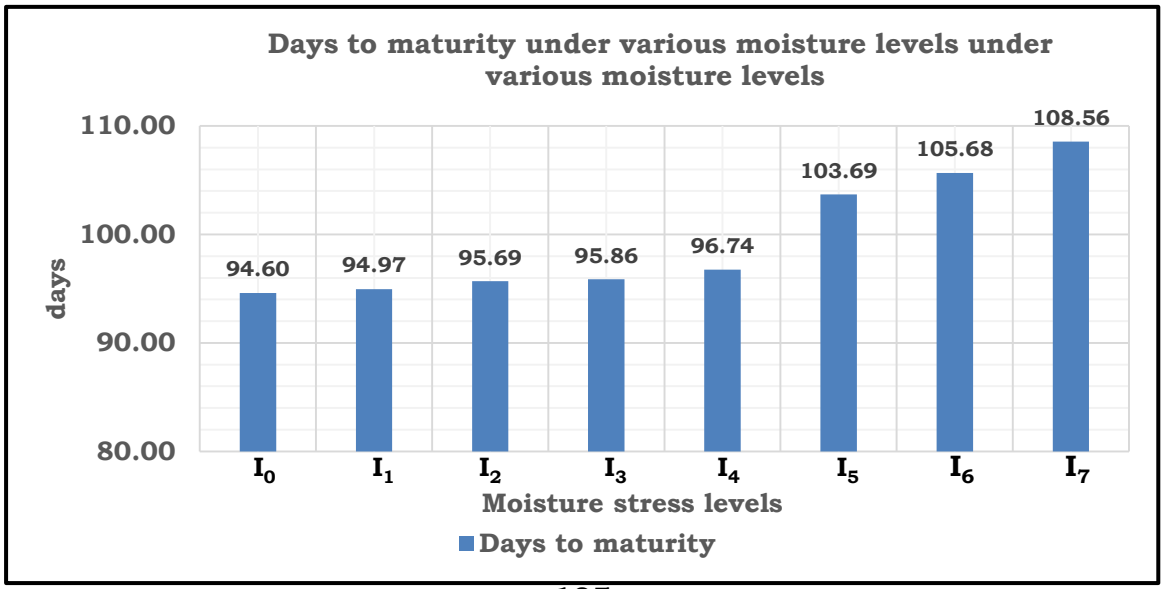


Fig.4 Mean days to maturity of six wal genotypes at various phases under different degree of moisture stress



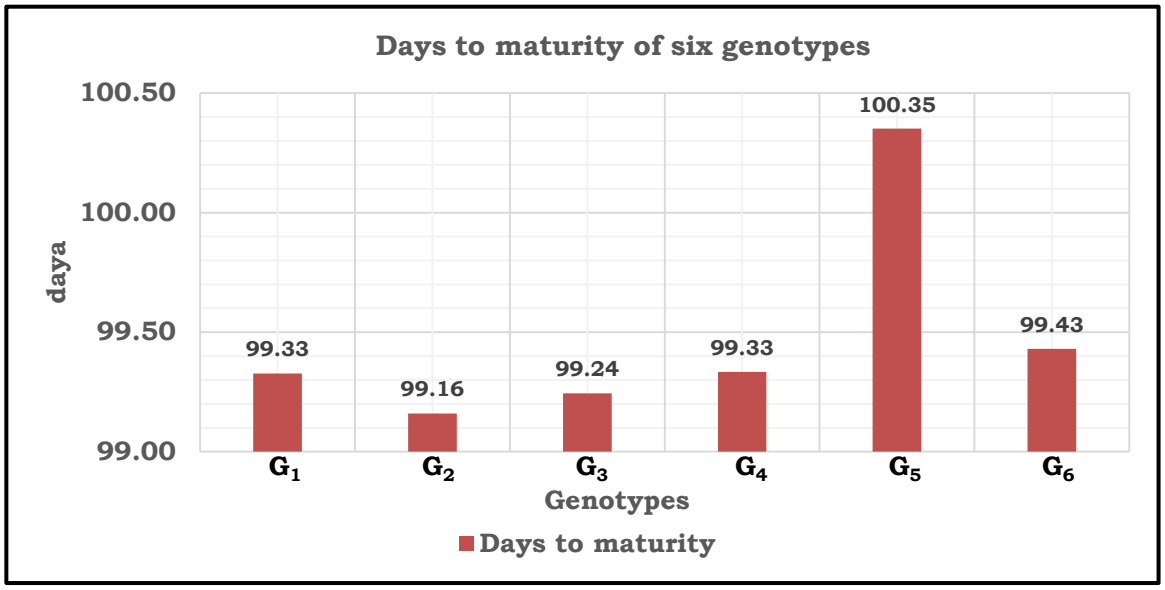
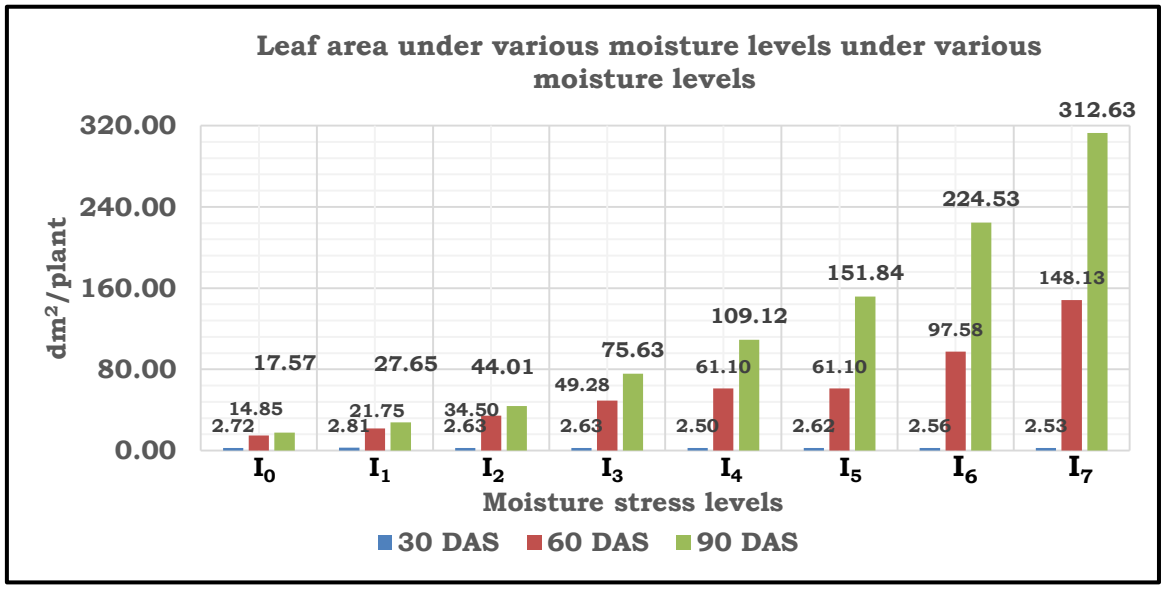


Fig.5 Mean leaf area (dm^2/plant) of six wal genotypes at various phases under different degree of moisture stress



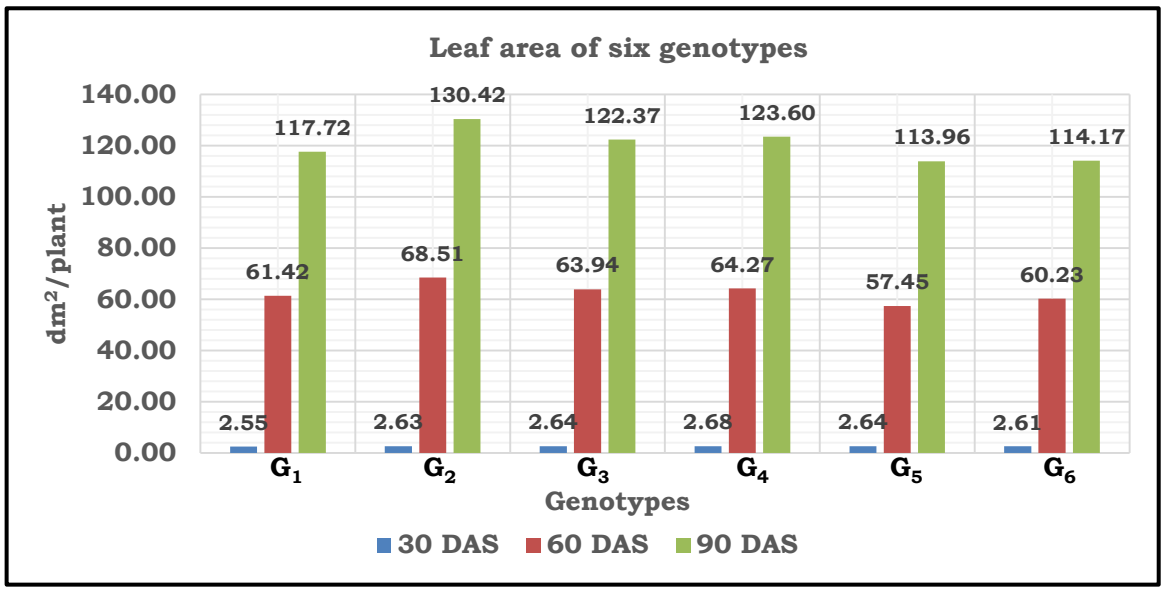
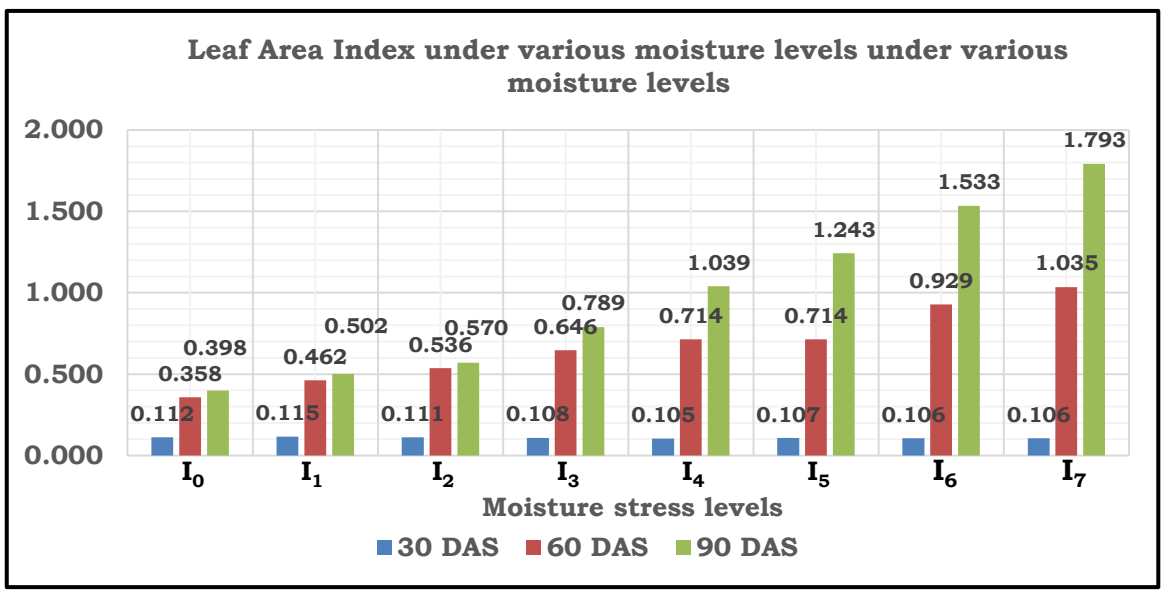


Fig.6 Mean leaf area index of six wal genotypes at various phases under different degree of moisture stress



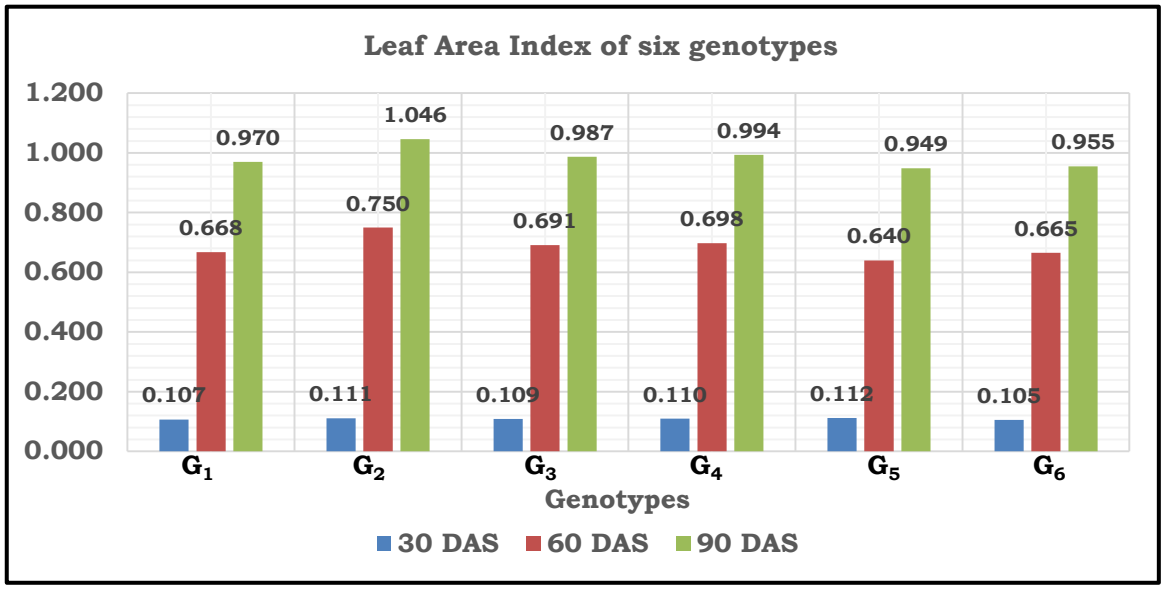
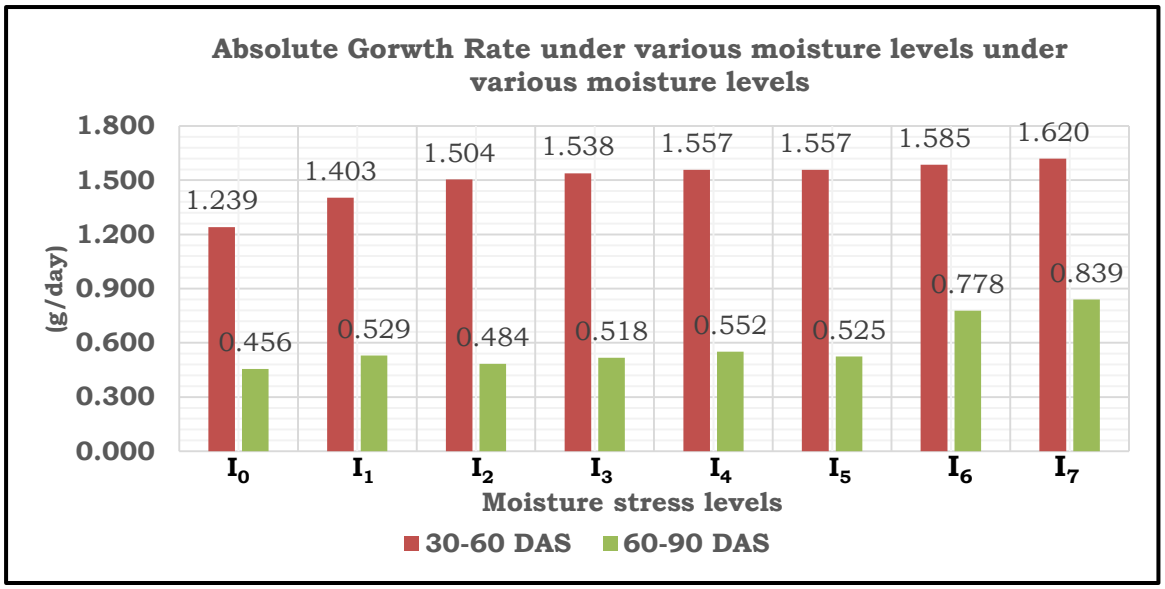


Fig.7 Mean absolute growth rate (g/day)of six wal genotypes at various phases under different degree of moisture stress


Absolute Gorwth Rate under various moisture levels under various moisture levels
1.800
1.500
1.200
0.900
0.600
0.300
0.000
(g/day)
1.239
0.456
1.403
0.529
1.504
0.484
1.538
0.518
1.557
0.552
1.557
0.525
1.585
0.778
1.620
0.839
I0
I1
I2
I3
I4
I5
I6
I7
Moisture stress levels
30-60 DAS
60-90 DAS

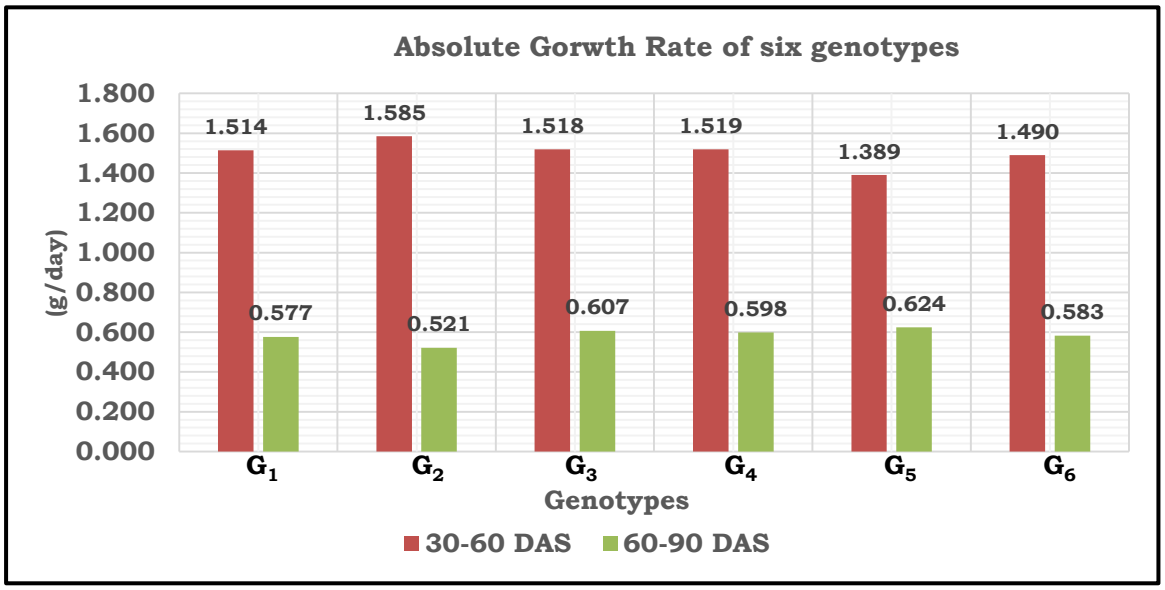
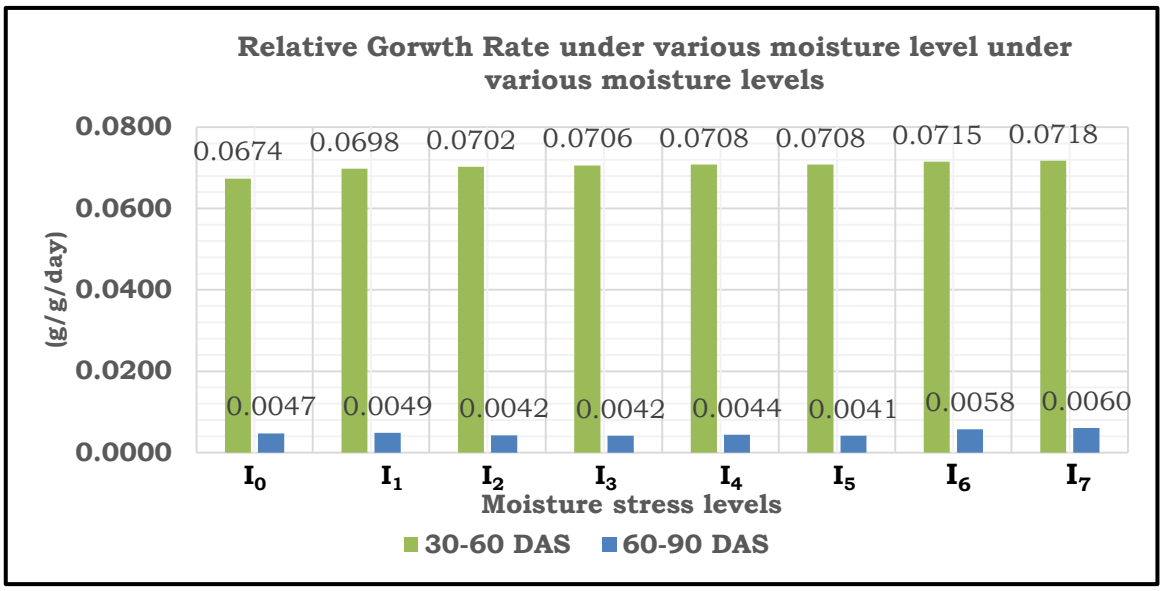

Absolute Gorwth Rate of six genotypes
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
(g/day)
1.514
0.577
1.585
0.521
1.518
0.607
1.519
0.598
1.389
0.624
1.490
0.583
G1
G2
G3
G4
G5
G6
Genotypes
30-60 DAS
60-90 DAS

Fig.8 Mean relative growth rate (g/g/day)of six wal genotypes at various phases under different degree of moisture stress



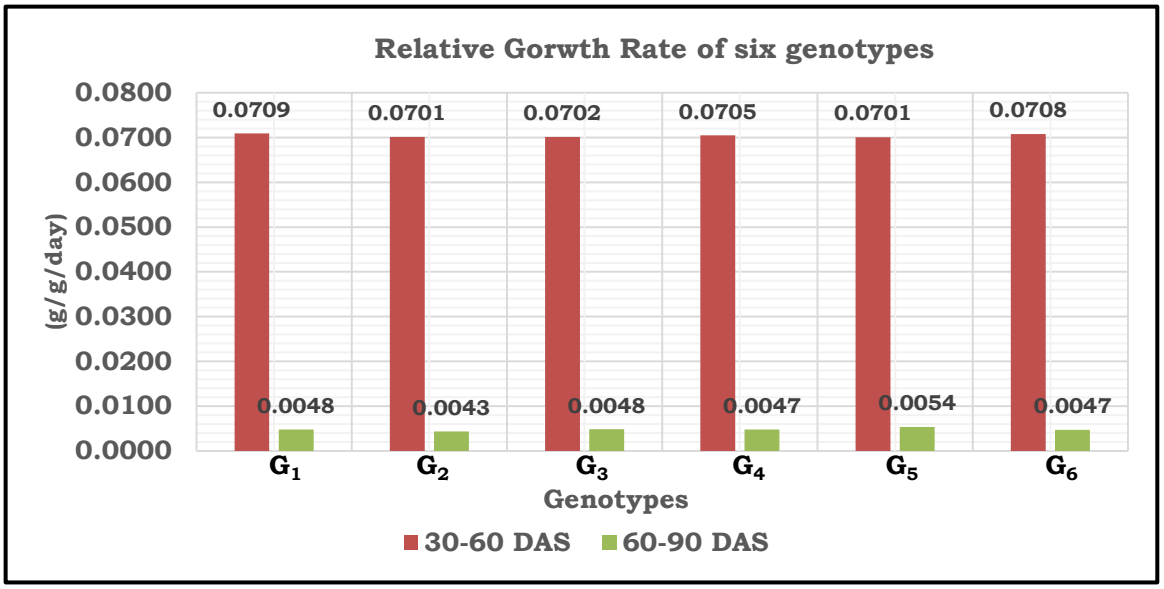
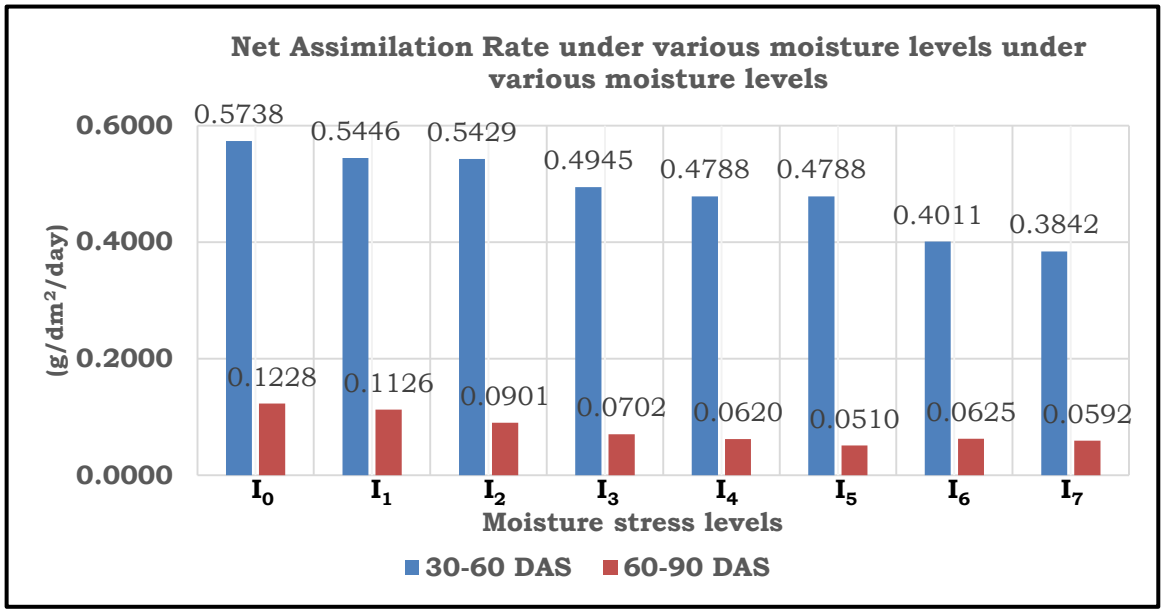


Fig.9 Mean net assimilation rate (g/dm^2/day)of six wal genotypes at various phases under different degree of moisture stress



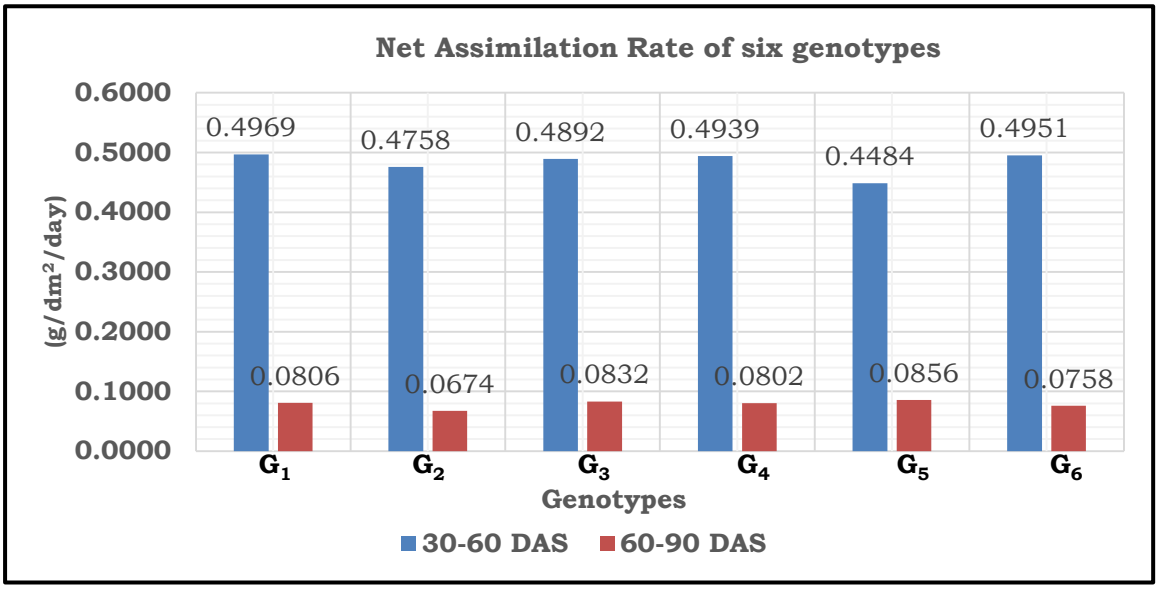
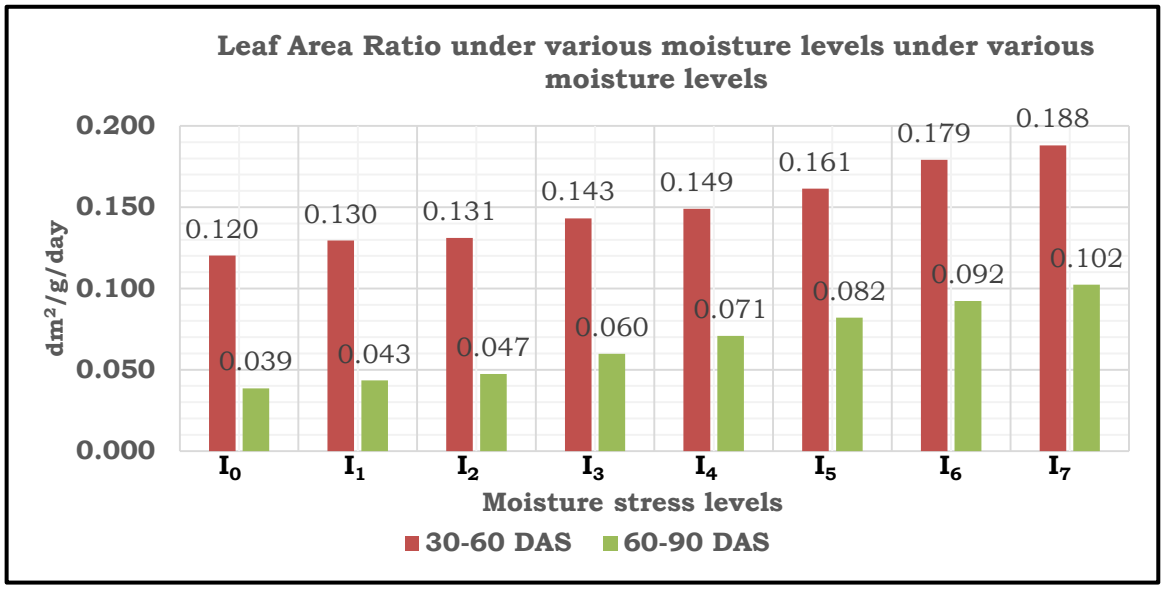


Fig.10 Mean net assimilation rate ($dm^2/g/day$)of six wal genotypes at various phases under different degree of moisture stress



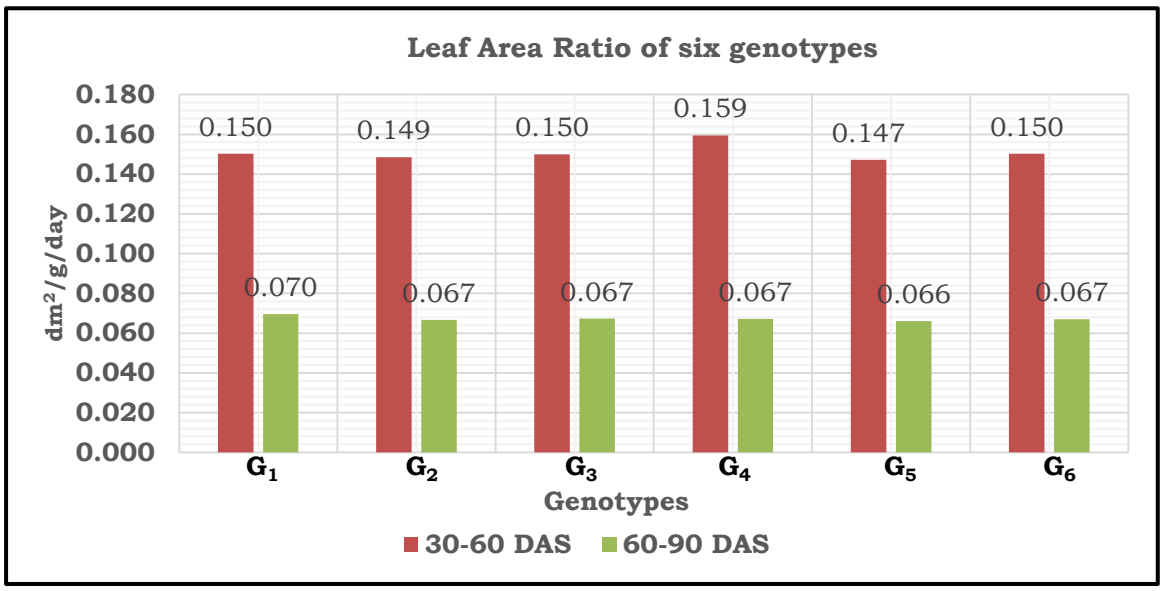
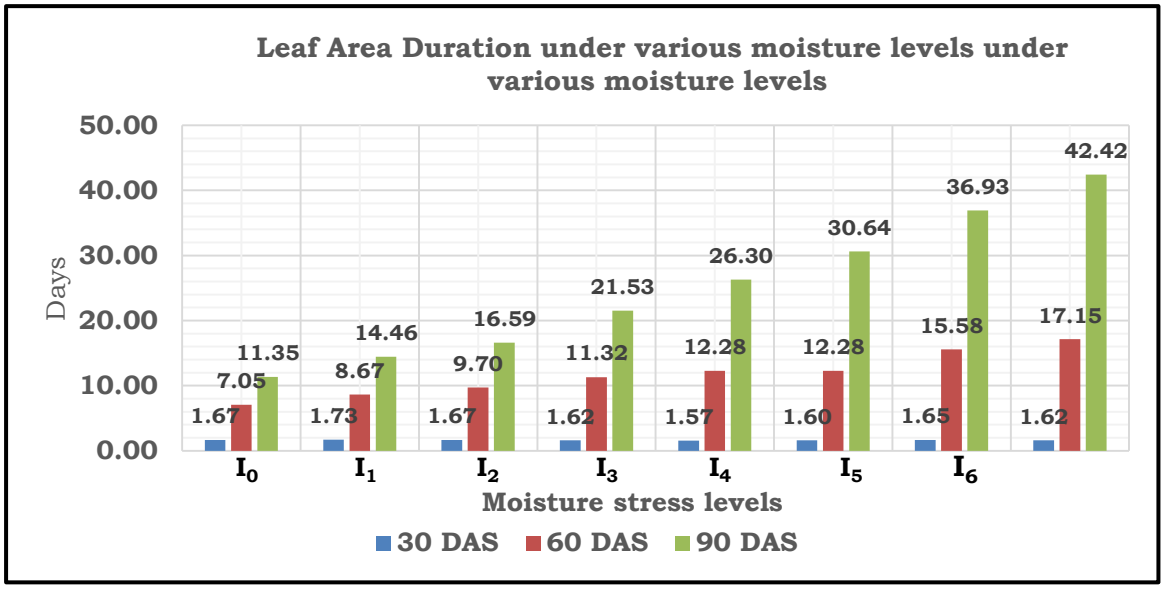


Fig.11 Mean leaf area duration (days)of six wal genotypes at various phases under different degree of moisture stress



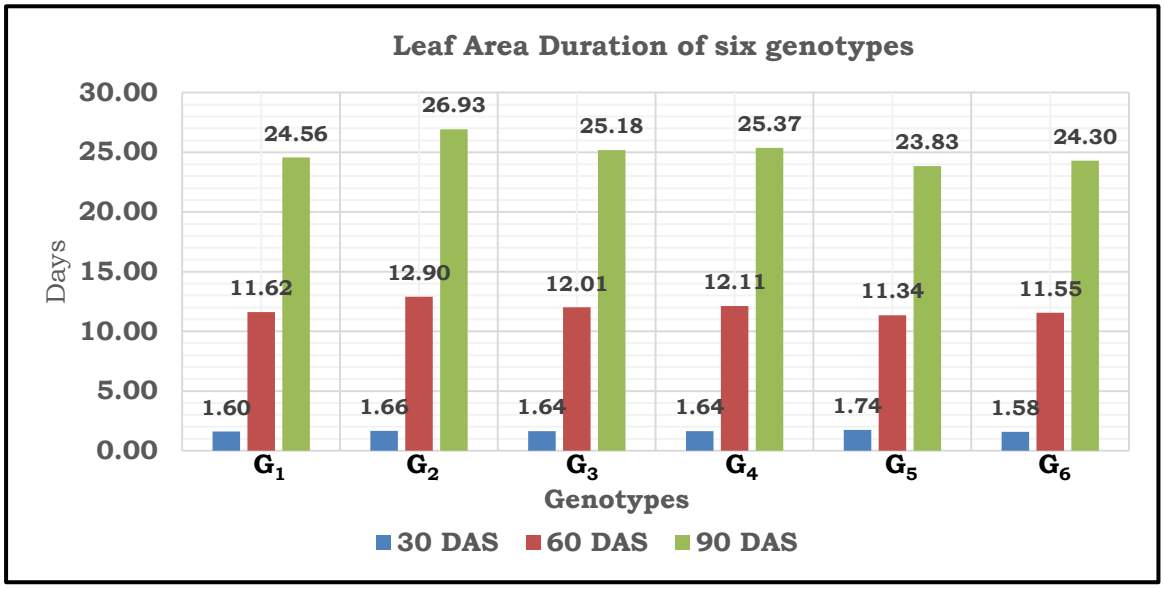
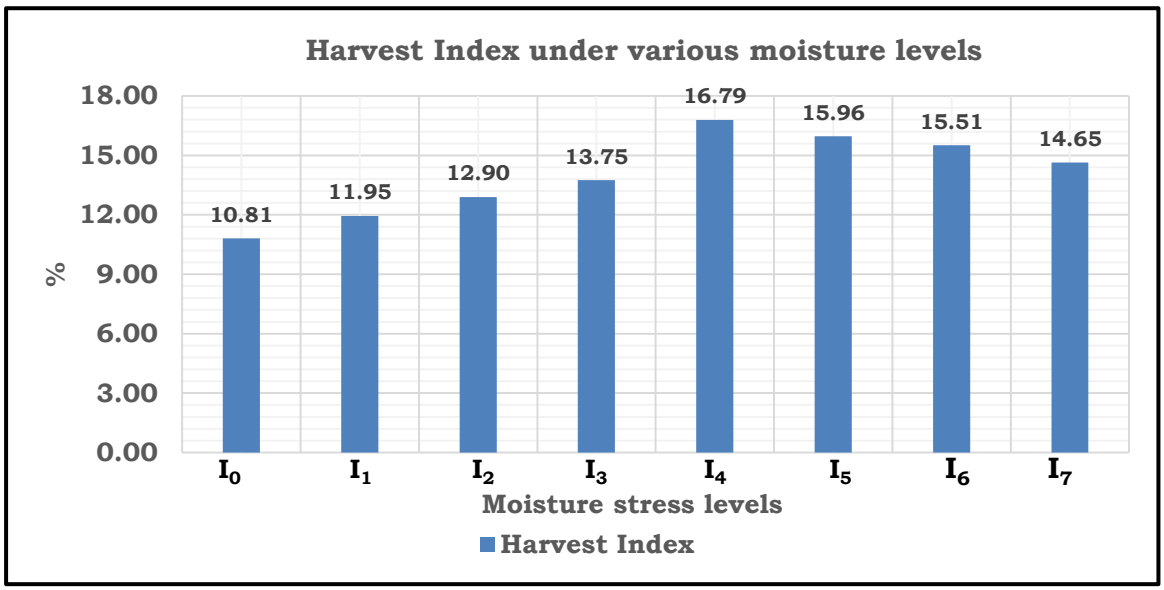


Fig.12 Mean harvest index (%)of six wal genotypes at various phases under different degree of moisture stress



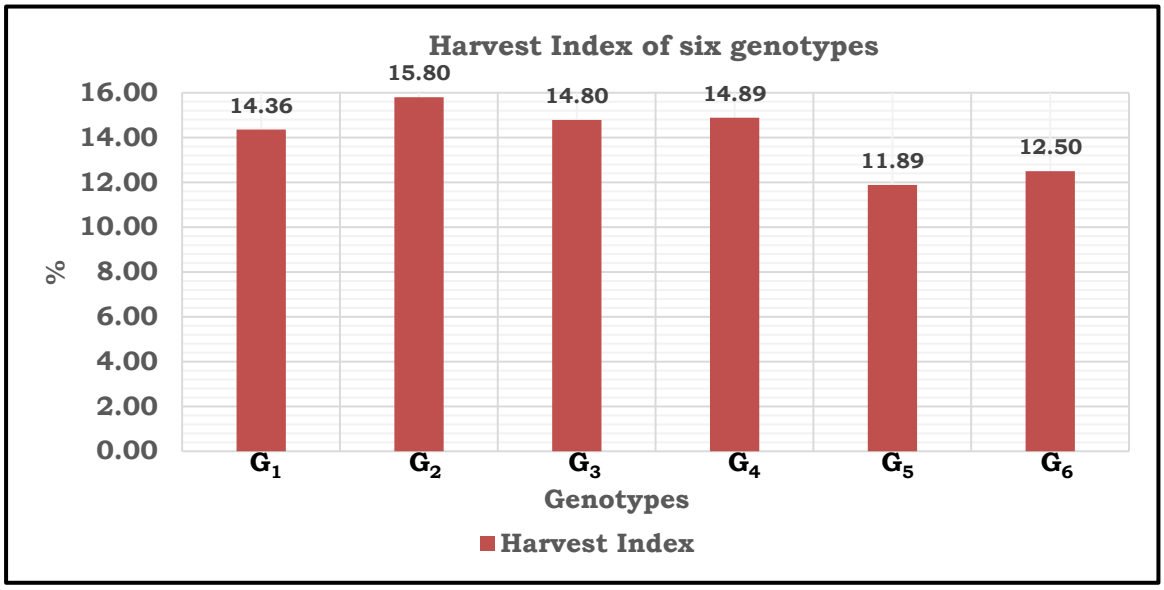
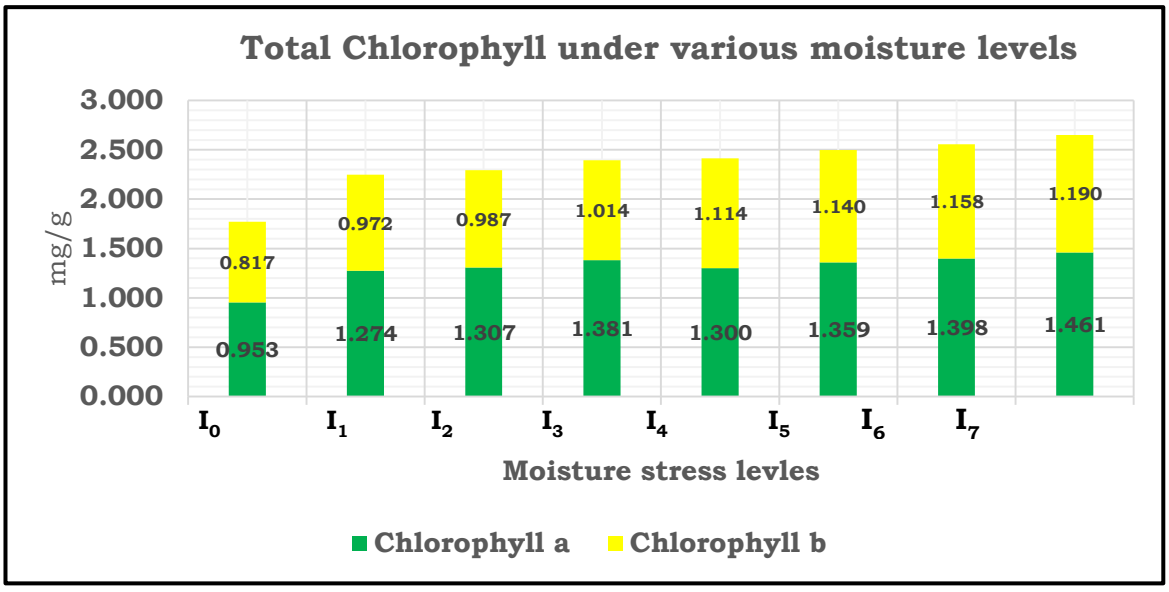


Fig.13 Mean total chlorophyll content (mg/g) of six wal genotypes at various phases under different degree of moisture stress



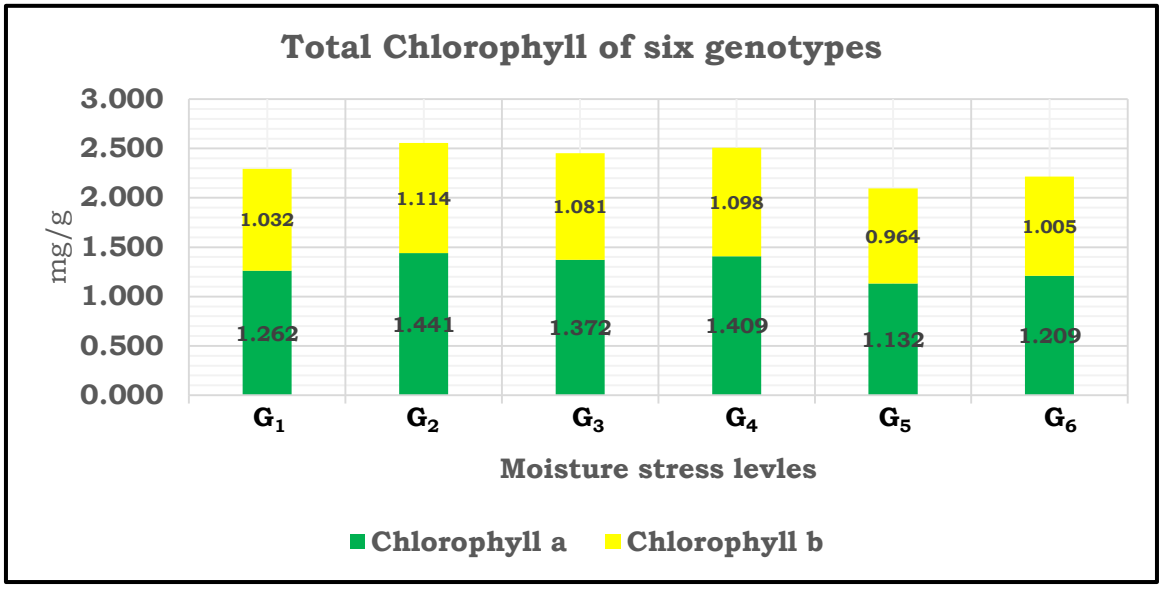
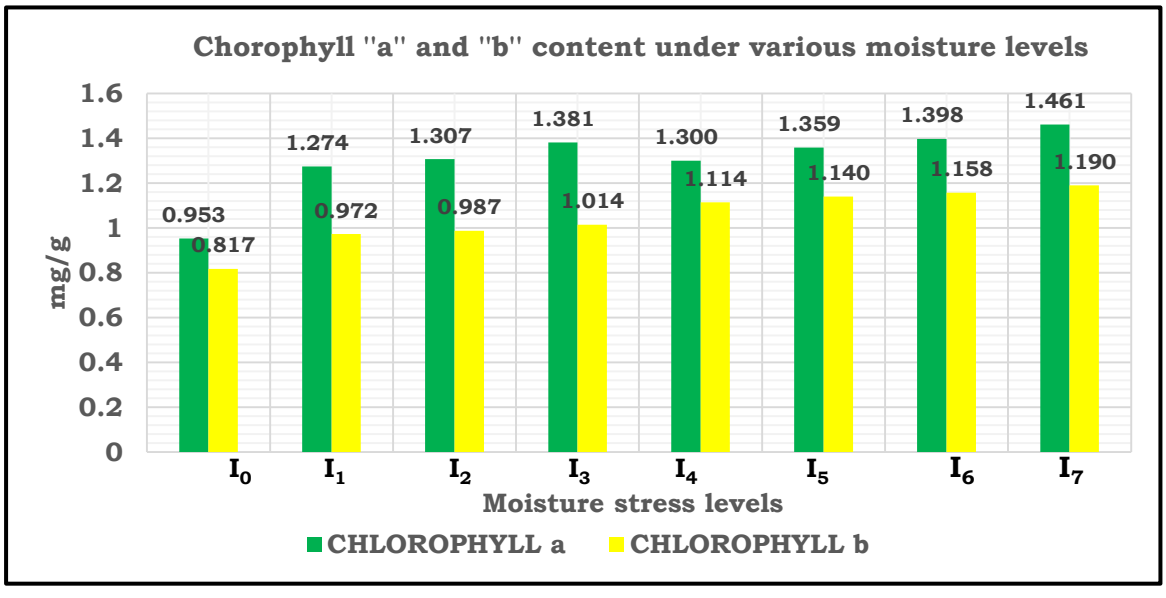


Fig.14 Mean chlorophyll “a” and “b”content (mg/g) of six wal genotypes at various phases under different degree of moisture stress



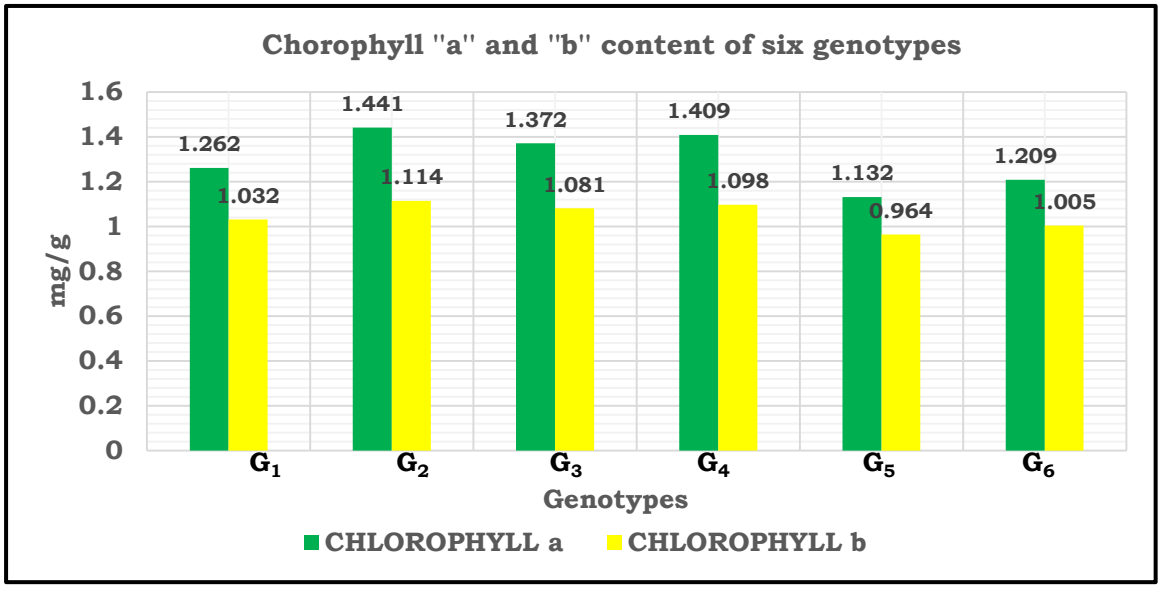
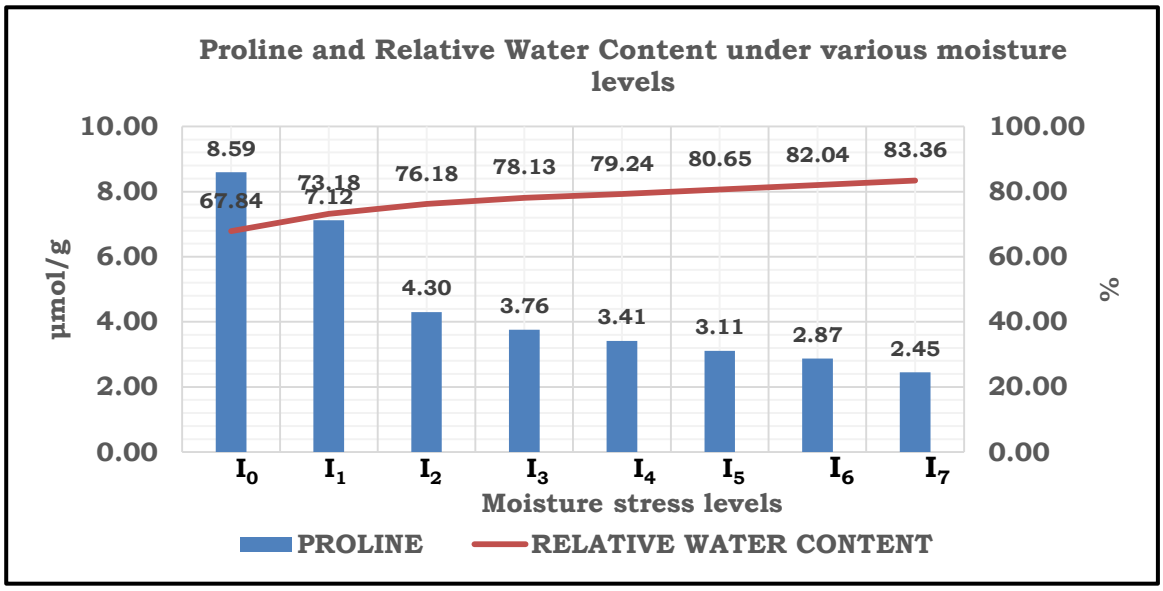


Fig.15 Mean proline(µmol/g)and relative water content(%)of six wal genotypes at various phases under different degree of moisture stress



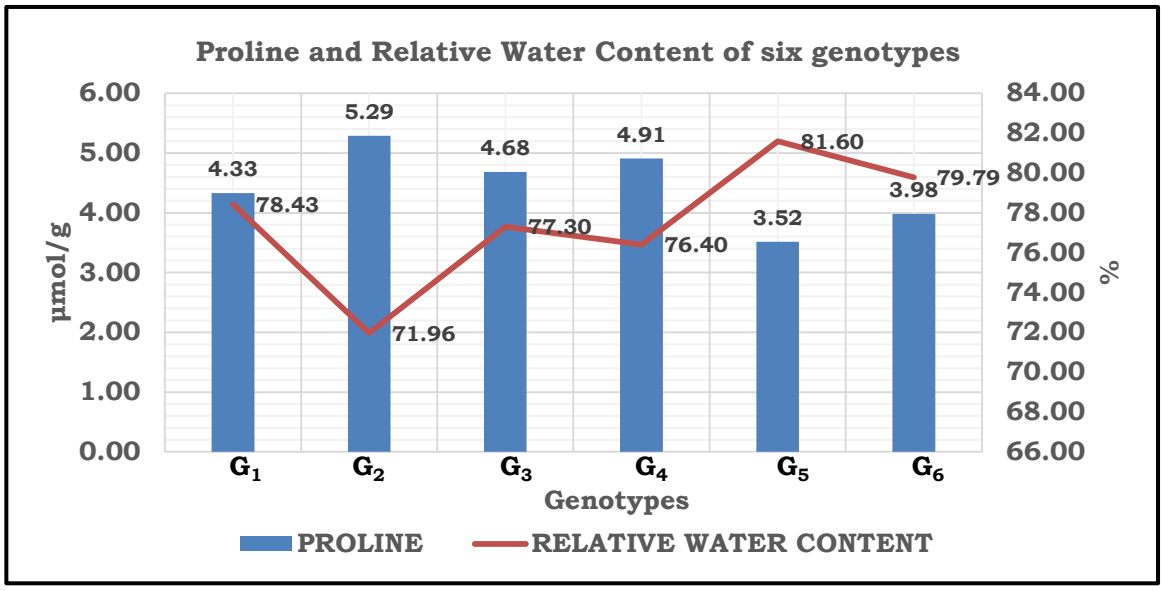
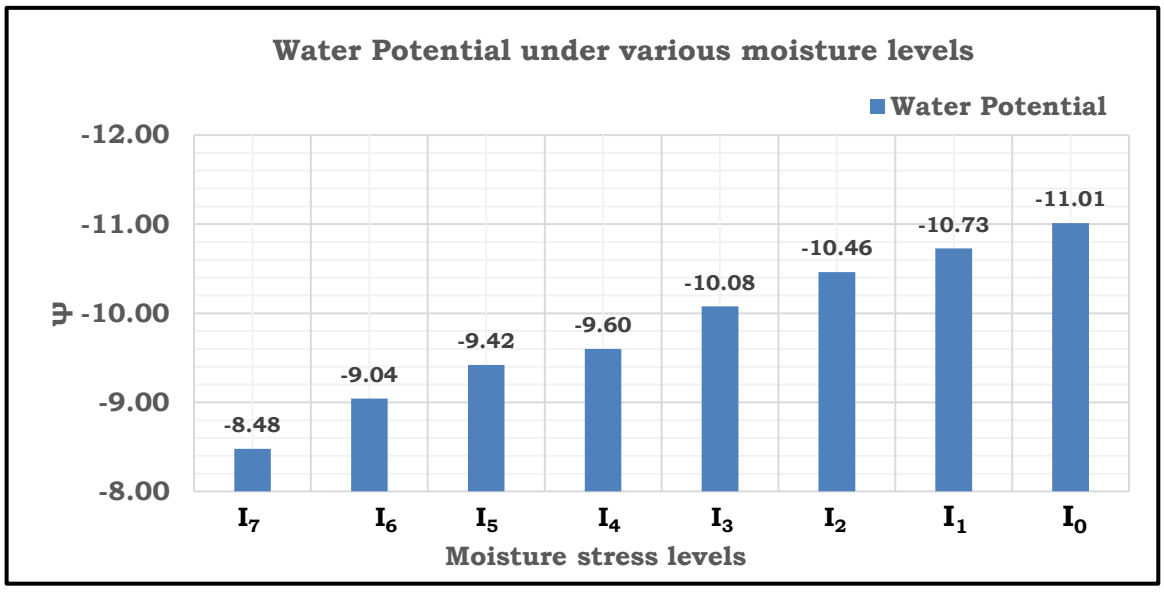


Fig.16 Mean water potential (bar) and relative water content(%) of six wal genotypes at various phases under different degree of moisture stress



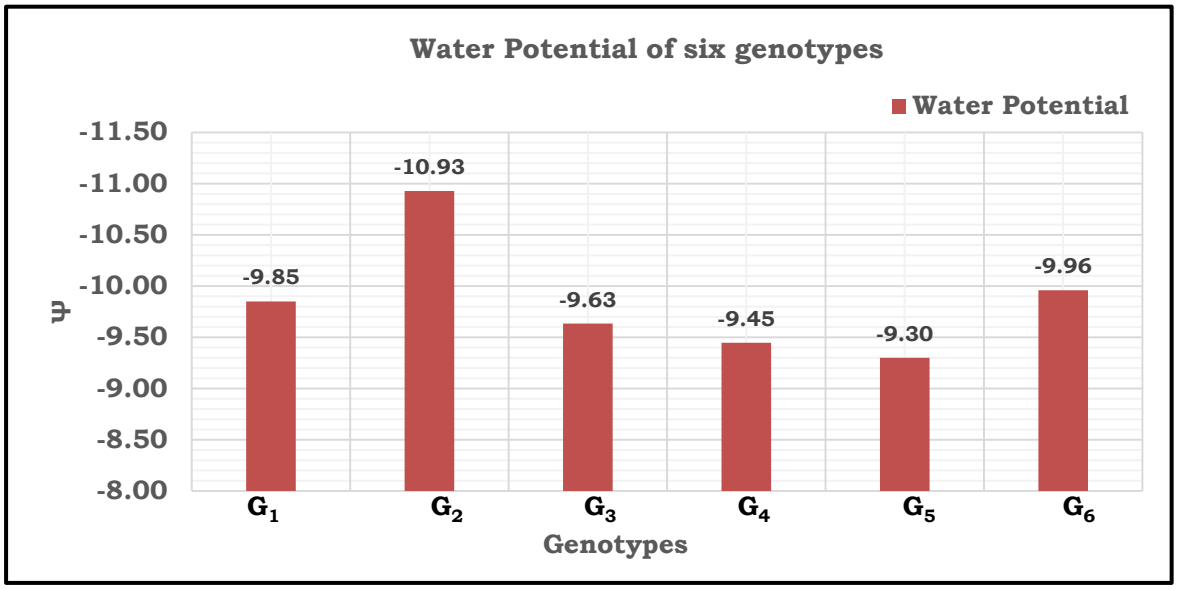
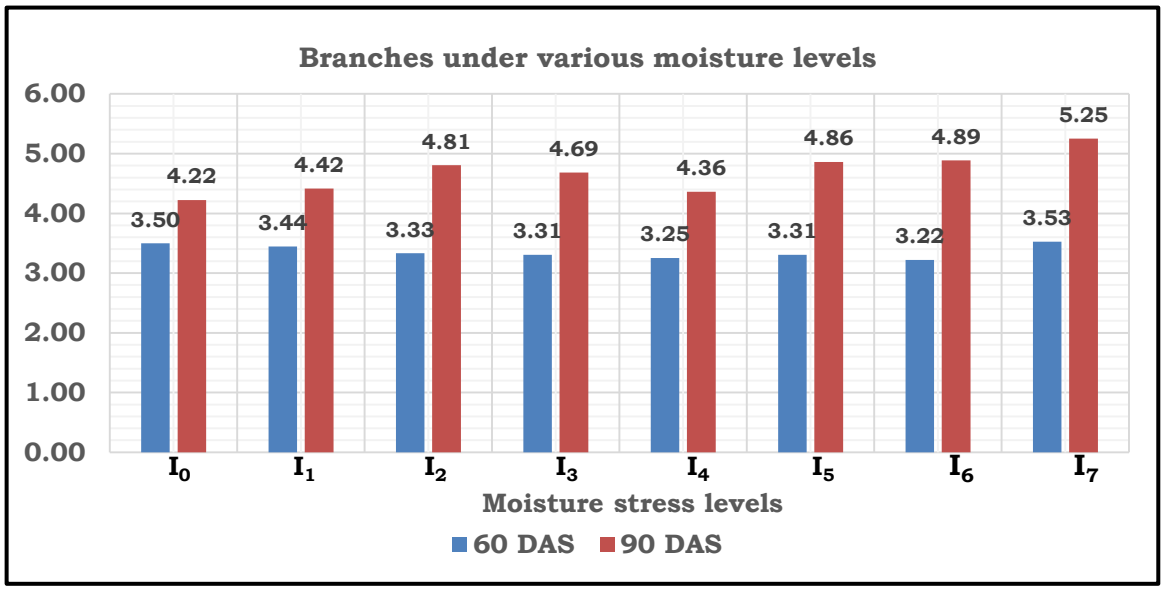


Fig.17 Mean number of branches of six wal genotypes at various phases under different degree of moisture stress



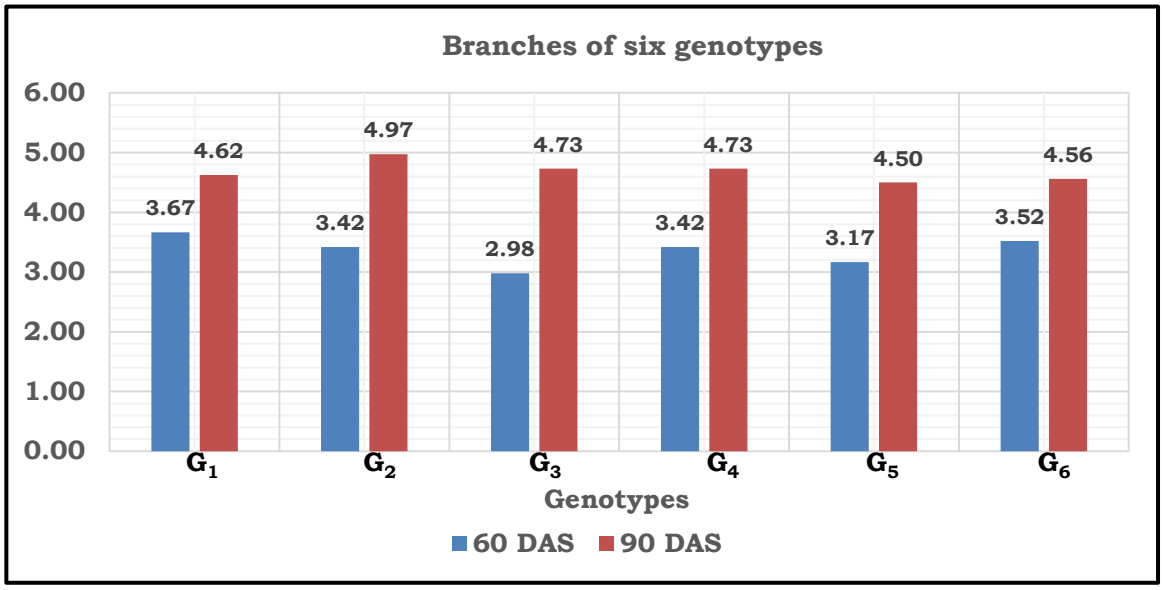
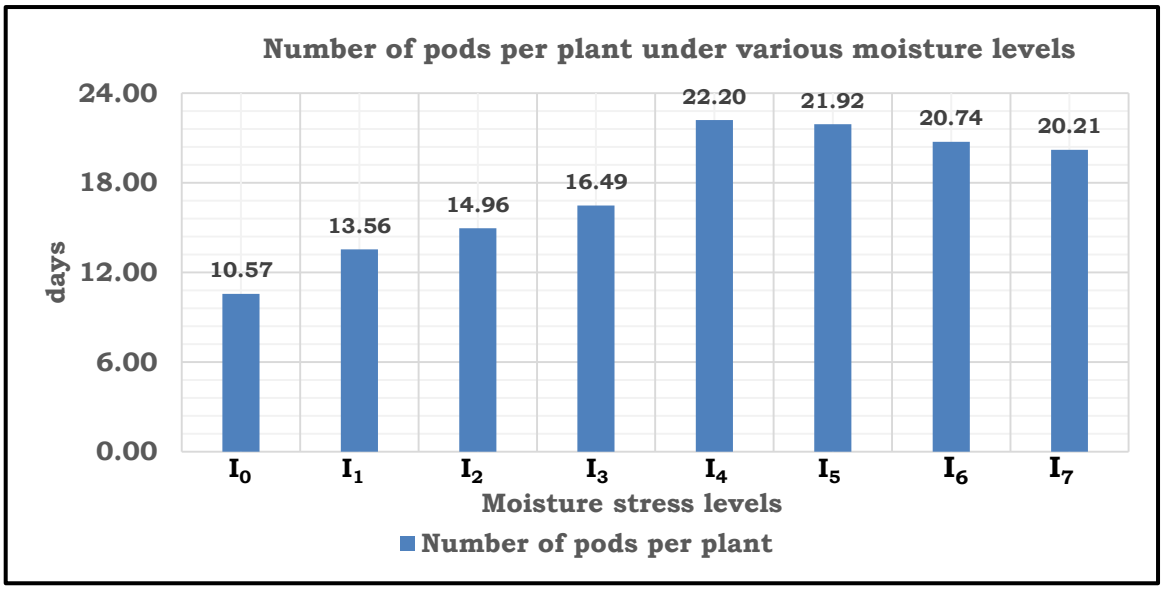


Fig.18 Mean number pods per plantof six wal genotypes at various phases under different degree of moisture stress



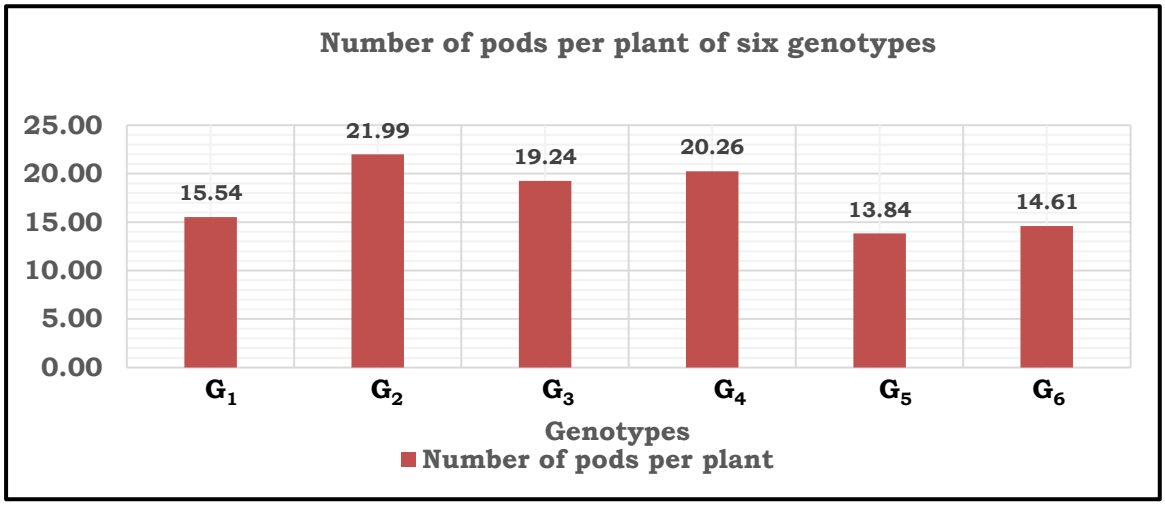
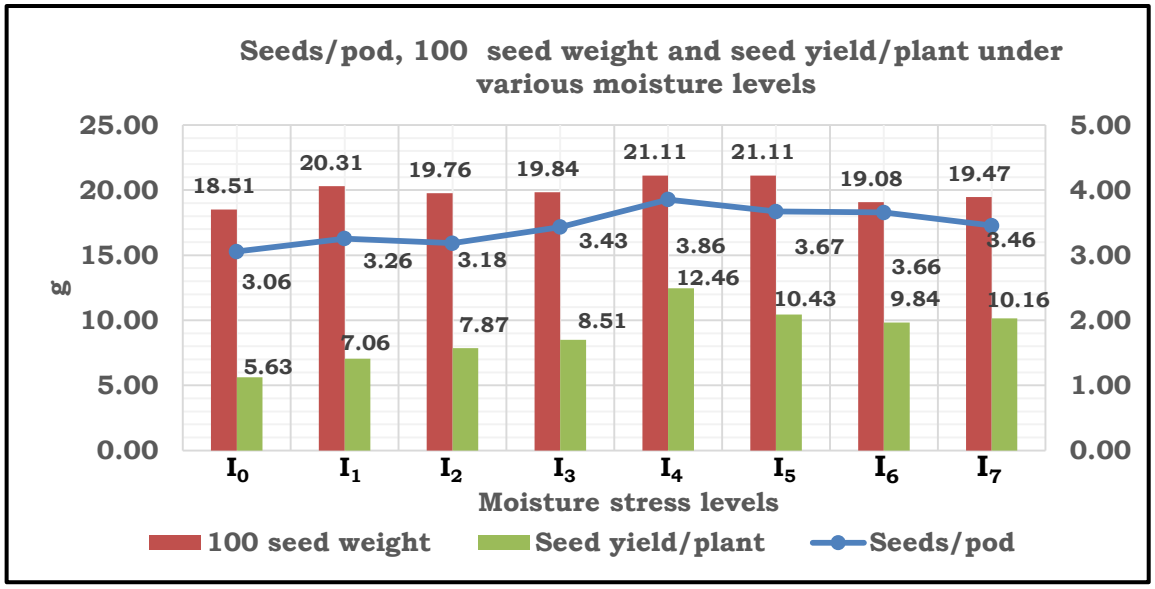
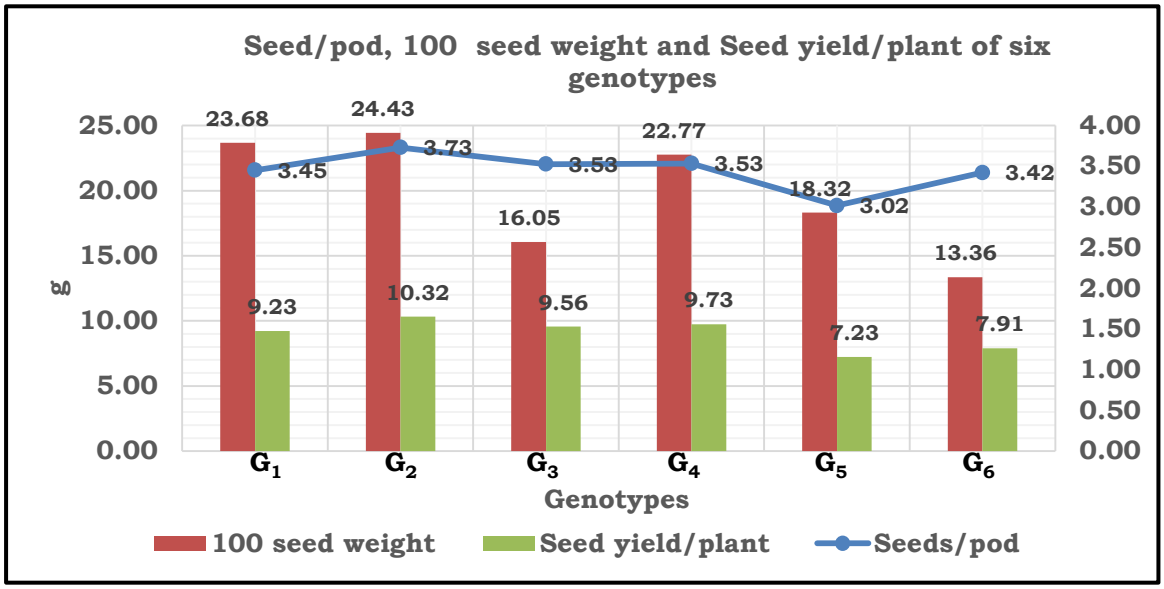


Fig.19 Mean seeds per pod, 100 grain weight (g) and seed yield (g) of six wal genotypes at various phases under different degree of moisture stress




Seed/pod, 100 seed weight and Seed yield/plant of six genotypes
g
25.00
20.00
15.00
10.00
5.00
0.00
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
23.68
24.43
22.77
18.32
16.05
13.36
9.23
10.32
9.56
9.73
7.23
7.91
3.45
3.73
3.53
3.53
3.02
3.42
G1
G2
G3
G4
G5
G6
Genotypes
100 seed weight
Seed yield/plant
Seeds/pod