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May, 2017

EFFECT OF SPACING AND FERTILIZER ON GROWTH AND YIELD OF YARD LONG BEAN (*Vignaunguiculata* sub Sp. Sesquipedalis (L.) Verdcourt)

A thesis submitted to the

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH,DAPOLI, (Agricultural University)
DIST. RATNAGIRI (Maharashtra), INDIA

In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE(HORTICULTURE)

In

Vegetable science

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CERTIFICATE

This is to certify that, the thesis entitled "**EFFECT OF SPACING AND FERTILIZER ON GROWTH AND YIELD OF YARD LONG BEAN (*Vignaunguiculata* sub Sp. Sesquipedalis (L.) Verdcourt)**" submitted to the Faculty of Agriculture, Dr. BalasahebSawantKonkanKrishiVidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra State in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (HORTICULTURE)** in**VEGETABLE SCIENCE**, embodies the result of a piece of bona-fide research carried out by**Ms. HARSHA DATTATRAY DANDILE** 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 him.

Place: Dapoli

Date: /May/2017

(Y. R. Parulekar)
Chairman,Advisory Committee
and Research Guide

CONTENTS

DEPARTMENT OF HORTICULTURE,
COLLEGE OF AGRICULTURE, DAPOLI

Title of Thesis	**:**	"Effect of spacing and fertilizer on growth, yield and quality of yard long bean (*Vignaunguiculata*sub sp. *Sesquipedalis*) var. 'KonkanWali'
Name of the student	**:**	**Miss. HarshaDattatrayDandile**
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Name of the Research Guide	**:**	**Prof. Y. R. Parulekar** Assistant Professor, Department of Horticulture, College of Agriculture, Dapoli

ABSTRACT

The present investigation entitled "Effect of spacing and fertilizer on growth, yield and quality of yard long bean (*Vignaunguiculata*sub sp. *Sesquipedalis*) var. 'KonkanWali' was conducted at Hi-tech unit, Department of Horticulture, College of Agriculture, Dapoli, and Dist. Ratnagiri during Rabi season, 2015-2016 in split plot design with three replications. Two factors were studied during the investigation *viz.*a) spacing S_1 (60 X 30 cm), S_2 (60 X 60 cm), S_3 (60 X 90 cm) as main plot treatment and b) fertilizer levels *viz.* N_1 (60:60:30 NPK kg/ha), N_2 (90:60:30 NPK kg/ha), N_3 (120:60:30 NPK kg/ha) as subplot treatments.

The result of investigation revealed that, all the three spacing recorded significant variation on differentgrowth parameter, physical parameters, yield and yield attributing characters as well as various flowering behavior under study.

With regards to variation in spacing, at 120 DAS, number of primary branches, number of nodes, internodal length, number of leaves, total leaf area werefound significant. The maximum number of primary branches was noticed in S_2 (17.82), highest number of

nodes was recorded in S_2 (283.7),highest internodal length was recorded in S_1 (22.42), highest number of leaves was recorded inS_2 (297.31), and highest total leaf area was recorded in S_2 (23597.09 cm^2).

The effect of spacing on number of days to first flowering was significant. The lowest days for initiation of first flower was noticed in S3 (70.27)

In yield and yield attributing characters,yield per plant, yield per plot and yield per hectare were significant.The highest yield per plant was recorded in S_1 (0.63 g). The highest yield per plot was recorded in S_1 (22.76 kg) and the highest yield per hectare was also recorded in S_1 (16.39 ton).

The effect of spacing on length of pod, number of seeds per pod, weight of green pod, weight of flesh per pod, weight of grains per pod was significant. The highest length of pod was recorded in S_3 (34.73 cm). The highest number of seeds per pod was also recorded in S_3 (15.84).The highest weight of green pod was recorded in S_1 (12.64).The highest weight of flesh per pod was recorded in S_1 (8.02) and highest weight of grains per pod was recorded in S_1 (3.58)

Further, observing the effect of nitrogen levels, at 120 DAS, number of primary branches, number of nodes, internodal length, number of leaves and total leaf area was found significant. The highest number of primary branches was noticed (50.98),highest number of nodes was recorded (275.96), and highest total leaf area was recorded in N_3 (225312.70 cm^2). The highest internodal length was recorded in N_1(22.22).The highest number of leaves was recorded in N_2 (306.71)

The effect of nitrogen on yield per plant, yield per plot and yield per hectare were significant. The highest yield per plant was recorded (0.61 g), highest yield per plot was recorded (13.94 kg), and highest yield per hectare was also recorded in N_1 (10.04ton).

The effect of nitrogen on length of pod, weight of flesh per pod and weight of grains per pod was significant. The highest length of pod was recorded in N_1 (34.66 cm).The highest weight of flesh per pod was recorded (8.00 g) and the weight of grains per pod was recorded in N_2 (4.11 g)

With regards to the interaction effect of spacing and nitrogenlevels, at 120 DAS, number of primary branches, number of nodes, internodal length, number of leaves and total leaf areawas found significant.The highest number of primary branches was noticed in (58.60), and the maximum number of nodes was noticed in S_3N_3 (316.40). The highest internodal length was recorded in S_1N_1 (24.38 cm), the highest number of leaves was recorded in S_2N_2 (377.67).

The effect of interactionon yield per plant, yield per plot and yield per hectare were significant. Highest yield per plant was recorded in (0.68 g). However, the highest yield per plot was recorded in (24.48 kg) and yield per hectare was also recorded highest in S_1N_1 (17.63 ton).

In case of the physical parameters, the interaction effect of length of pod, number of seeds per pod, weight of green pod, weight of grains per pod was non-significant and weight of flesh per pod was significant. The highest weight of flesh per pod was recorded in S_1N_2(10.27 g).

Thus from the present investigation entitled "Effect of spacing and fertilizer on growth, yield and quality of yard long bean (*Vignaunguiculata*sub sp. *Sesquipedalis*) var. 'KonkanWali' it was concluded that for better vegetative growth, yield and yield contributing charactersyard long bean should be planted at the spacing of 90×30 cm with application of compost 15t/ha and fertilizer dose of 60:60:30 NPK kg/ha.However, same investigation should be continued for 2 more seasons for confirmation of present result.

Acknowledgement

Firstly, I would like to express my sincere graceful filled thanks to "ALMIGHTY GOD" who bestowed me with tenacity, good health, zeal and in whose faith, I was able to cross this important milestone of academics career. Before I stop, I pray for his blessings to be with me till the end of this life journey.

At this movement of accomplishment, first of all I pay homage to my guide and chairman of my advisory committee **Prof. Y. R. Parulekar**, Assistant Professor, Department of Horticulture, College of Agriculture, Dr. B.S.K.K .V. Dapoli, for his unquestioned mastery on thesis subject, talented and versatile advice and scholastic guidance, profound interest in research and kind treatment throughout the course of my post graduate study. His words can always inspire me and bring me to a higher level of thinking. He is guide in the true sense of the word and for that, I am highly obliged.

This manuscript will remain incomplete, if I will be failing in my duties to express my heartfelt gratitude to the member of my advisory committee, **Dr. P. C Haldavnekar**, Associate Director of Research, Regional Fruit Research Station, VengurleDist- Sindhudurg, for his valuable support, exemplary guidance, monitoring, constructive criticism and his extensive discussion around my research work.

I also extent my gratefulness to the other members of my advisory committee, **Dr. V. V. Dalvi**, Senior scientist, AICRP on Agroforestry, Central Experimental Station, Wakawali, Department of Botony; **Dr. P. M. Haldankar**,

Associate Dean college of Horticulture, Mulde for their excellent guidance, consistent inspiration, keen interest and helpful discussion throughout the post-graduation studies. I am very grateful to **Dr. B. R. Salvi** for his support, encouragement and valuable guidance throughout my course of study.

I am thankful to Honorable**Dr. T. Bhattacharya**, Vice-Chancellor, Dr.BalasahebSawant Konkan Krishi Vidyapeeth, Dapoli, **Dr. R. G. Burte**, Dean, Faculty of Agriculture, Dr.BalasahebSawant Konkan Krishi Vidyapeeth, Dapoli, and **Dr. U. V. Mahadkar**, Associate Dean, College of Agriculture Dapoli for providing all the infrastructure facilities for the smooth and successful conduct of research work.

It is a friend who shares your secrets and who provides crutches to the crumbling house of confidence. Words are inadequate to convey the depth of my heartfelt thanks to my vegies friends **Vipul, Vikrant, Rohit, Balaji, Omkar, Basav, Harshad, Hema**and fruties friends **Afreen, Reshma,Tejarti, Snehal, Nitin, Nandu,**for their excellent company and co-operation.

I also take this opportunity to express my affection and obligation to my best friends forever **Mayur, Pamya, Jaggu, Sahil, Bapu, Vaibhav, Ashish, Dagadu dada, Govind dada, Sachin, Parmeshwar,Ajay, Vijay**and Ph.D. scholar's **Dr.NavdeepMhatre**and **Dr. VishalKedari**, for their excellent company and co-operation.

I am also thankful to my UG friends **Seema, Neha**, Shamika, Snehal, Pooja, Avdhoot, Dhananjay, Mayur, Kapil, Bhagya, Sonali, Sugandha, Ashutoshand my

close once **Sarvdnya**, **Swara**, Purvi, Jayesh da, Tushar da and Aditi vahini, Roshni tai and Dinesh Jiju, Mr. and Mrs. Mhatre, Mr. and Mrs. Kadam, Mr. and Mrs.Raskar, Mr. and Mrs. Borate, Mohit, Bapu-Kaki, Vaishalivahini,**Priyanka**,Tanu, Manish, Meenakshi, Ranjeet, Navnath, Umesh dada, Sagar dada, Snehadidi, Sushant, Sonal,Amit, Ashwini, Shubhangi,Bhushan, Umesh,Dr.Khaire.

Last but not least, there are no words which can express my feelings about my beloved parents **Mr. DattatrayDandile**and **Mrs. LatikaDattatrayDandile** for their love, care, sacrifices and encouragement. I would like to extend my thanks to my dearest brother **Rahul DattatrayDandile**and my mother in low, father in low, sachinbhauji and Pooja tai and my future better half **sagar**who always wanted my success inspired me with their love, affection, blessings and all that they have done for me.

Once again, I would like to acknowledge all those who I might have left on unknowingly.

Place: Dapoli

Date: May, 2017 (Harsha D. Dandile)

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APPENDIX I

ABBREVIATIONS USED

%	:	Per cent
/	:	Per
@	:	At the rate
^{0}C	:	Degree Celsius
Anon.	:	Anonymous
C.D.	:	Critical difference
cm	:	Centimeter (s)
cm^2	:	Square centimeter
Cv.	:	Cultivar
Et al.	:	and others
etc.	:	Et cetra
Fig.	:	Figure
FYM	:	Farm yard manure
g	:	Gram
ha	:	Hectare
i.e.	:	That is
kg	:	Kilogram (s)
Lit.	:	Litre (s)
m	:	Meter (s)
max.	:	Maximum
min.	:	Minimum
MSl	:	Mean sea level
R.H.	:	Relative humidity
Sr.No.	:	Serial number

SSP	:	Single super phosphate
S.E.	:	Standard error
Var.	:	Variety
Viz.	:	Namely
N.S.	:	Non-significant
t	:	Ton

CHAPTER I
INTRODUCTION

Yard long bean (*Vignaunguiculata*sub sp. Sesquipedalis (L) verdcourt 2n=22) belonging to family leguminaceae is cultivated mainly for its crisp and tender green pods which are consumed both fresh as well as in cooked form. It is also known as snake bean, asparagus bean due to its long slender pods. However, it is popularly known as wali in Konkan region.

Among different vegetables,leguminous crops play an important role as it is the only source of vegetable protein which is required for human health. They also provide minerals, vitamins and fibers. It constitute about 10-12% of the Indian diet. According to WHO recommendation, the intake of leguminous should be 80g/day/capita.Similarly, leguminous vegetables are lesser probes to climatic changes and helps in maintaining soil health and thus, are important contributors of profitable cropping system.

Yard long bean belongs to sub family – Papilionaceae and family –Leguminosae it is viny, indeterminate in growth habit, leaves are trifoliate and green in color. Flowers are of papilionaceous type with violet color. Pods are long, slender and pendent with sparely arranged bold seeds. The pods have great demand in Gulf countries and large quantities are exported to the Middle East.

Yard long bean is considered to be originated in Central Africa and widely distributed in India, Indonesia, Phillippines and Sri-lanka. According to Verdcourt (1970),cowpea has five sub-species,which are *cylindrica, sesquipedalis, dekindtiana, unguiculata*and *menensis.* Among them, *cylindrical,sesquipedalis*and *unguiculata* are cultivated species, whereas *dekindtiana* and *menensis* are wild ones.

Considering the nutritive value, 100 g of green pods of yard long bean contain energy (34.00 Kcal), protein (4.20 mg), calcium (110.00 mg), iron (4.70 mg), vitamin 'A' (2.40 mg), vitamin 'C' (35.00 mg) and is also good source of lysine (Anon; 2006). Green pods are used as sole vegetable or with potato.Fiber in particular eases the digestive system and gives a sense of long lasting satiety. It can be used as medicine to help kidney's and spleen's function,and to reduce cholesterolin the blood (Rubatzky and Yamaguchi,1997).

It is pole type legume and required support for its proper growth. Pods are long slender and pendent with sparely arranged bold seeds. The pods have great demand in gulf countries and large quantities are exported to Middle East.

Konkan is a high rainfall area with lateritic soils where rice based cropping system is popularly followed by vegetables wherever irrigation is available after withdrawal of rain.The agro climatic condition of Konkan region are very much suitable for yard long bean cultivation.It is mainly a warm season crop and can survive extreme humidity and heat but it is very sensitive to cold temperature. It has secured a key position in rice based cropping system of Konkan.

Yard long bean is popularly grown after rice as *rabi* and summer season crop on commercial scale especially in south Konkan i.e. in Ratnagiri and Sindhudurg districts. It is also grown in *kharif* especially in background for fulfilling the family vegetable need. Its cultivation was earlier concentrated in south Konkan particularly Sindhudurg district which is now increasing in other district of Konkan as well as in rest of Maharashtra. It's long slender, tender pods are cooked to prepare excellent tasty dish with potato. The pods fetche's attractive market price and are having

great demand in local as well as metropolitan markets like Panjim, Mhapusa,Kolhapur,Mumbai, Ratnagiri etc.

The variety KonkanWali is released by Dr. BalasahebSawantKonkanKrishiVidyapeeth, Dapoli in the year of 1996. The plant growth habit is viny, with dark green foliage. Average yield is 60-70 quintal per hectare.

The crop is gaining commercial importance especially under south Konkan conditions.However, so far very limited attempts have been made to study the various production practices for yard long bean. It is multiple harvest crop. The yield ultimately depends upon the plant population and growth of plant. The growth of plant is dependent on nutrient supply. The recommendation regarding proper spacing and fertilizer dose will help the farmers to maximize yield of yard long bean and in turn it also will help to increasethe returns.

Therefore, the present study “Effect of spacing and fertilizer on growth and yield of yard long bean (*Vignaunguiculata*sub sp. Sesquipedalis (L) verdcourt)” was undertaken with following mentioned broad objectives.

1) To study the effect of different spacing’s on growth and yield of yard long bean.
2) To study the effect of various fertilizer doses on growth and yield of yard long bean.

CHAPTER II
REVIEW OF LITERATURE

The present investigation entitled "Effect of spacing and fertilizer on growth and yield of yard long bean (*Vigna unguiculata* sub Sp.Sesquipedalis (L.) Verdcourt) was carried out during 2015-2016.The review of related work was done so as to formulate the research project. The research work on spacing and fertilizer requirement of yard long bean is limited. Hence, the review of research on other leguminous crops been done. The review done has been presented with following subtitles.

2.1 **Effect of spacing, nitrogen and their interactions on vegetative growth of yard long bean.**

2.1.1 **Effect of spacing**

Lee (1983)The effect of plant spacing on growth and yield of winged bean (*Psophocarpus tetragonolobus*).It was revealed that Wider spacing of 50 (3.6) and 75 cm (3.8) produced significantly more basal branches perplant than did the closer spacing.

Mahaldar (1986) studied the effect of recommended spacing on plant height up to harvest in cowpea. The spacing of 20 X 15 cm produced significantly taller plants (48.11 cm) over 30 X 15 cm (46.58 cm) and 45 X 15 cm (45.32 cm). However, the plant height at 30 X 15 cm and 45 X 15 cm were at par with each other.

Sarvaiya *et al.* (1993) while observing effect of spacing on plant height in cowpea, observed that significantly maximum plant height (204.40 cm) was recorded at 60 cm and maximum number of branches (25.3) per plant were observed at 120 cm spacing.

Parameswari *et al.* (2003) in their study conducted on pigeon pea found that plant spacing significantly influenced the plant height at 30, 60 and 120 days after sowing in both the seasons

(Sept., 2000 and July, 2001). The 45 X 20 cm spacing with a plant population of 44,446 plants per hectare recorded the highest plant height of 67.80 cm and 53.10 cm and least number of branches of 6 and 4 at 60 days after sowing in both September and July sown crop.

Swain and Rath (2006) in yam bean crop reported that plant height was significantly higher (46.85 cm) in wider spacing of 45 X 45 cm followed by spacing of 30 X 30 cm.

Pawar *et al.* (2007) carried out an investigation on the performance of French bean (*Phaseolus vulgaris*) cultivars under a plant spacing of 30x10cm (3.33 lakh plants/ha), 45x10cm (2.22 lakh plants/ha) and 45x15cm (1.48 lakh plants/ha) in Parbhani, Maharashtra, India, during the *rabi* season of 2003-04 and reported that a spacing of 45x10cm and 45x15cm gave the highest number of branches per plant (5.65 and 5.71, respectively), number of functional leaves per plant (1.52 and 1.62), mean leaf area (2.61 cm^2 and 3.04 cm^2) and 30x10 cm was optimum for plant height (32.24 cm).

Bokade (2008)studied spacing effect in yard long bean with the three spacing levels *viz,* 60 ×120cm (S_1), 75×120cm (S_2), 90×120cm (S_2). From the studies, it was concluded that spacing of 75×120cm (354.67) recorded plant height which was highest as compared with other spacing levels and result obtained was significant.

Chakravorty *et al.* (2009) determined the effect of spacing on growth and yield of French bean with nine levels of spacing. Closely spaced plants attained maximum plant height, minimum number of branches and minimum leaves per plant.

Kachare *et al.*, (2009) revealed that the highest total leaf area of green gram was recorded in moderate spacing of 30 X 11.25 cm

(8.29 cm^2) as compared to other spacing levels *viz.*, 22.5 X 15 cm (7.66 cm^2) and 45 X 7.5 cm (7.66 cm^2).

Satodiya *et al.* (2015)observed that planting density of 60 x 30 cm recorded the highest plant height of cowpea [*Vigna unguiculata* (L) Walp] under Anand conditions. However, it was comparable with 45 x 45 cm.

Murade *et al.*, (2014) conducted a field experiment at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akoladuring *Kharif* season on Blackgram. The growth character i.e. number of leaves were recorded maximum under wider spacing of 45 X 15 cm (9.34) than closer spacing 30 x 15 cm (8.63).Total leaf area was recorded higher under wider spacing of 45 X 15 cm (11.69) than closer spacing 30 x 15 cm (10.62).

Adigun *et al.*, (2014) studied the spacing effect in cowpea atOgun State, Nigeria.It was concluded that spacing maintained at 75 cm (95.02) in early season and at 60 cm (100.71) in late season recorded highest average leaf area as compared with other treatments and at 60 cm (92.37) in early season and (93.83) in late season recorded highest number of leaves as compared with other treatments. Results obtained were non-significant.

Nersekar (2016) stated that highest plant height, highest number of leavesand total leaf area was noticed in 60 X 60 cm spacing whereas; it was lowest in 60 X 30 cm in yam bean.

Kadam and Khanvilkar (2015)revealed that the number of leaves (12.64) and number of primary branches per plant (6.84) were significantly greater under wider spacing of 45 X 15 cm as compared to other spacing levels *viz.* 22.5 x 15 cm and 30 x 15 cm.Whereas plant height (32.93 cm) was significantly greater under lowest spacing of 22.5 x 15 cm in green gram.

2.1.2**Effect of nitrogen**

Verenkar (1985) found that mean plant height per plant in lentil crop increased significantly with increase in the level of nitrogen. The highest plant height of 65.60 cm per plant and highest number of branches (8.43) per plant were recorded at the highest dose i.e. 37.5 kg nitrogen per hectare. However, lowest plant height of 44.73 cm was recorded at control.

Mohopatra (1998) observed significant increase in plant height of 46.0 cm in rice bean at 30 kg nitrogen per hectare and primary branches per plant (5.20).

Swain and Rath (2006) studied the effect of application of different levels of fertilizer in yam bean and recorded the maximum increase in plant height (46.16 cm) when crop was supplied with 45:30:0 kg NPK per hectare.

Bokade (2008) reported that effect offertilizer in yard long bean with four nitrogen levels *viz,* 60:60:0 kg N/ha (T_1), 60:60:30 kg N/ha (T_2), 60:60:45 kg N/ha (T_3), 60:60:60 kg N/ha (T_4), applied in split plot design. The result showed that the application of nitrogen had non-significant effect on number of nodes and significantly increased the average leaf area (21283cm^3) in F_3.

Hasan *et al.* (2010) studied effect of nitrogen levels in cowpea with five nitrogen levels in cowpea *viz,* 0 (T_0), 15 (T_1), 20 (T_2), 25 (T_3) and 30 (T_4) kg N/ha, applied in 20 plots in a Completely Randomized Design (CRD). The result showed that the application of nitrogen fertilizer had significant ($P<0.01$) effect on plant height and highest plant height (96.25 cm) was observed at 25 kg N/ha and non-significant effect on number of primary branches.

Rathod and Gawande (2012) revealed that green gram crop was sown with three levels of fertilizersat Department of Agronomy,

College of agriculture, Latur, India. However, the application of 30:60:00 kg NPK/ha (F_3) (4.71 cm^2) recorded significantly higher total leaf area followed by application of 20:40:00 kg NPK/ha (F_1) (2.50 cm^2) and 25:50:00 (F_2) (2.23 cm^2).

2.1.3 **Effect of spacing and nitrogen**

Vakeswaran and Vijayakumar (2005) imposed treatments with four spacing (2.5, 5.0, 7.0 and 10 cm between plants and a uniform spacing of 40 cm between rows) and three levels of NPK fertilizers (80:60:50; 120:80:70 and 160:100:90 kg/ha) on seed crop of pea (*Pisum sativum L.*) cv. Bonneville at Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. Observations made on plant height were significantly influenced by spacing and fertilizer levels.

Swain and Rath (2006) studied comparative effect of three levels of fertilizers (F_1= 15:10:0, F_2= 30:20:0 and F_3= 45:30:0 kg NPK/ha) and three levels of spacing (S_1= 20 X 20 cm, S_2= 30 X 30 cm and S_3= 45 X 45 cm) in yam bean. The treatment combination of F_3S_3 (45:30:0 kg NPK per hectare and spacing 45 X 45 cm) recorded significantly maximum plant height of 50.13 cm.

Bokade (2008) studied comparative effect of three levels of spacing's *viz,*60 ×120cm (S_1), 75×120cm (S_2), 90×120cm (S_2) and four levels of fertilizer *viz,*60:60:0 kg N/ha (T_1), 60:60:30 kg N/ha (T_2), 60:60:45 kg N/ha (T_3), 60:60:60 kg N/ha (T_4). Observations made on number of primary branches were significantly influenced by spacing and fertilizer levels.

2.2 **Effect of spacing, nitrogen and their interactions on flowering behavior of yard long bean.**

2.2.1 **Effect of spacing**

Lee (1983) evaluated that effect of plant spacing on growth and yield of winged bean (*Psophocarpus fetragonolobus* (L,)O.C.) cultivar Chimbu at Guam Agricultural Experiment Station. Appearance of first flower ranged from 63 to 71 days (table 1). First flowering in closer spacing (12.5 cm) was significantly delayed by 8 days longer than that in wider spacing (75 cm).

Bokade (2008) studied the effect of spacing in yard long bean with the three spacing levels *viz,*60 ×120cm (S_1), 75×120cm (S_2), 90×120cm (S_3). From the study, it was concluded that the spacing maintained at 90×120cm (58.92) recorded more number of days to 50% flowering as compared with other spacing levels and result obtained was significant

2.2.2 Effect of nitrogen

Bokade (2008) reported that effect of fertilizer in yard long bean with four nitrogen levels *viz,*60:60:0 kg N/ha (T_1), 60:60:30 kg N/ha (T_2), 60:60:45 kg N/ha (T_3), 60:60:60 kg N/ha (T_4), in split plot design. The result showed that application of nitrogen fertilizer had non-significant effect on number of days to 50% flowering.

2.2.3 Effect of spacing and nitrogen

Vakeswaran and Vijayakumar (2005) studied the effect of treatments with four spacing's (2.5, 5.0, 7.0 and 10 cm between plants and a uniform spacing of 40 cm between rows) and three levels of NPK fertilizers (80:60:50; 120:80:70 and 160:100:90 kg/ha) in seed crop of pea (*Pisum sativum L.*) cv. Bonneville. Observations made on number of days to first flowering were significantly influenced by spacing's and fertilizer levels.

2.3 **Effect of spacing, nitrogen and their interactions on yield and yield attributing character of yard long bean.**

2.3.1 **Effect of spacing**

Pande *et al.* (1974) conducted the trial on spacing of 30-60 cm in French bean and observed that pod yield/ha was highest at the widest spacing.

Lee (1983) result revealed effect of plant spacing on growth and yield of winged bean (*Psophocarpus fetragonolobus* (L,) cultivar Chimbu at Guam Agricultural Experiment Station. Plant spacing's included 12.5, 25.0, 50.0 and 75.0 cm within row and the same between-row spacing of 1.22 m. Plant spacing significantly influenced the number of green pods per plant. The winged bean grown in wider plant spacing (75 cm) produced almost 5 times more green pods than that of closer spacing (12.5 cm).

Sharma *et al.* (2008) conducted an experiment under greenhouse to study the effect of four sowing dates and two plant densities *viz.* 30x10 cm and 45 x 10 cm on two cultivars of French bean (*Phaseolus vulgaris*) and found that the 45x10 cm spacing showed a significant increase in pods per plant compared to the 30x10 cm spacing.

Bokade (2008) studied spacing effect in yard long bean with three spacing levels *viz,* 60 ×120cm (S_1), 75×120cm (S_2), 90×120cm (S_3). The results showed that the spacing levels had non-significant effect on duration for harvest and spacing maintained at 90×120cm recorded highest green pod yield per plant per hectare (4.73) as compared with other spacing levels and result obtained was significant.

Chaudhary (2009) evaluated the effect of row spacing, seed rate and nitrogen levels on growth and yield of French bean

(*Phaseolus vulgaris*). The row spacing of 30 and 40 cm being at par produced significantly higher grain yield of French bean than 20 cm row spacing.

Kachare *et al.*, (2009) revealed that the highest number of pods of green gram recorded in moderate spacing of 30 X 11.25 cm (22.77) as compared to other spacing levels *viz.*, 22.5 X 15 cm (22.35) and 45 X 7.5 cm (21.28).

Dev (2010) observed that the French bean Cv. Lakshmi as an autumn crop planted during Mid-August at a spacing of 90x15 cm produced maximum pod yield than the crop spaced at 60x15 cm and 75x 15 cm.

Nersekar (2016) recorded the highest yield per hectare in 60 X 20 cm and lowest in 60 X 60 cm in yam bean.

Yadav *et al.*, (2014) conducted a field experimentin Gujrat with treatments comprised of three levels of row spacing (S1 = 30 cm × 15 cm, S2 = 45 cm × 15 cm and S3 = 60 cm × 15 cm). The results revealed that the maximum green pod yield (94.48 q/ha) was recorded in closer row spacing (30×15 cm) in cluster bean.

Murade *et al.*, (2014) resulted afield experiment conducted at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* season on Black gram. The grain yield/plant wasrecorded higher under wider spacing (45x10 cm) than closer spacing(30x10 cm).

Joshi and Rahevar (2015) observed that the number of pods per plant were significantly higher (27.1) when crop was sown at 60 cm row spacing as compared to 30 cm and 45 cm using variety Gujarat Val 1 of Indian bean (*Dolichus lablab* L.).

2.3.2 Effect of nitrogen

Bokade (2008) studied the effect of fertilizer in yard long bean with four nitrogen levels *viz,*60:60:0 kg N/ha (T_1), 60:60:30 kg N/ha (T_2), 60:60:45 kg N/ha (T_3), 60:60:60 kg N/ha (T_4). The results showed that the application of nitrogen fertilizer had significant effect on green pod yield per plant per hectare and significantly increased the green pod yield per plant per hectare (4.58) in F_4 and had non- significant effect on number of pickings.

2.3.3 Effect of interaction

Vakeswaran and Vijayakumar (2005) in their study imposed the treatments with four spacing's (2.5, 5.0, 7.0 and 10 cm between plants and a uniform spacing of 40 cm between rows) and three levels of NPK fertilizers (80:60:50; 120:80:70 and 160:100:90 kg/ha on seed crop of pea (*Pisum sativum L.*) cv. Bonneville. Observations made on number of pods per plant were significantly influenced by spacing's and fertilizer levels.

Bokade (2008) studied comparative effect of three levels of spacing's *viz,*60 ×120cm (S_1), 75×120cm (S_2), 90×120cm (S_2) and four levels of fertilizer *viz,*60:60:0 kg N/ha (T_1), 60:60:30 kg N/ha (T_2), 60:60:45 kg N/ha (T_3), 60:60:60 kg N/ha (T_4). Observations made on green pod yield per plant per hectare were significantly influenced by spacing and fertilizer levels.

2.4 Effect of spacing, nitrogen and their interaction on physical parameters of yard long bean.

2.4.1 Effect of spacing

Lee (1983) reportedeffect of plant spacing on growth and yield of winged bean (*Psophocarpus fetragonolobus* (L,)O.C.) cultivar Chimbu. Plant spacing's included 12.5, 25.0, 50.0 and 75.0 cm within row at the same between-row spacing of 1.22 m. Plant spacing significantly influenced the number of green pods per

plant.The winged bean grown in wider plant spacing (75 cm) produced almost 5 times more green pods than that of closer spacing (12.5 cm) and green pod weight of winged bean grown at closer plant spacing's was significantly lighter than that at the wider spacing's. Green pod weight at plant spacing 12.5, 25, 50, and 75 cm were 21.1, 22.2, 26.1 and 29 g, respectively.

Mohapatra (1998) in his experiment on rice bean found that the wider spacing of 40 X 10 cm significantly increased the seed yield by 18.8 per cent and pods per plant by 17.2 over closer spacing of 30 X 10 cm.

Singh and Behera (1999) observed that the physical parameters such as length of pod (15.53 cm) and pod weight of French bean showed maximum values (8.43 g) at nitrogen level of 62.5 kg nitrogen per hectare.

Pawar *et al.* (2007) carried out an investigation on the performance of French bean (*Phaseolus vulgaris*) cultivar under a plant spacing of 30x10 cm (3.33 lakh plants/ha), 45x10 cm (2.22 lakh plants /ha) or 45x15 cm (1.48 lakh plants /ha) cm during the *rabi* season of 2003-04. A spacing of 45x10cm and 45x15cm gave the more number of grains per plant (25.86 and 25.95 respectively) and highest pod weight (11.28 and 11.38 g).

Bokade (2008) studied the spacing effect in yard long bean with the three spacing levels *viz,*60 ×120cm (S_1), 75×120cm (S_2), 90×120cm (S_3). The result showed that the spacing levels had non-significant effect on length of pod.

Kachare *et al.*, (2009) conducted a field trial at Department of Botany, MPKV, Rahuri. Revealed that the highest number of seeds per pod of green gram recorded in moderate spacing of 30 X 11.25 cm (9.47) as compared to other spacing levels *viz.*, 22.5 X 15 cm (9.27) and 45 X 7.5 cm (9.26).

Satodiya *et al.*, (2015)at Anand, observed that the planting density of 45 x 45 cm recorded maximum pod weight of cowpea [*Vigna unguiculata* (L) Walp] which remained at par with planting density 60 x 30 cm.

Joshi and Rahevar (2015) noticed that the length of pod and higher number of seeds per pod (3.3) was significantly higher when crop was sown at 60 cm (4.5) row spacingusing variety Gujarat Val 1 of Indian bean (*Dolichus lablab* L.)

2.4.2 **Effect of nitrogen**

Singh and Behera (1999) observed that the physical parameters such as girth of pod (3.50 cm) of french bean showed maximum values at nitrogen level of 62.5 kg nitrogen per hectare.

Bokade (2008) studied the effect of fertilizer in yard long bean with four nitrogen levels *viz,* 60:60:0 kg N/ha (T_1), 60:60:30 kg N/ha (T_2), 60:60:45 kg N/ha (T_3), 60:60:60 kg N/ha (T_4). The results showed that the application of nitrogen fertilizer had significant effect on length of pod and highest length of pod (43.89cm) was observed at 60:60:0 kg N/ha (F_1).

Rathod and Gawande (2012) revealed that weight of pods per plant was recorded significantly highest in F_3 =7.60 g (30:60:00 kg NPK/ha), and weight of seeds per pod was also recorded highest in F_3 =4.61 g. as compared to other fertilizer doses i.e.F_2 (25:50:00 kg NPK/ha) and F_3 (20:40:00 kg NPK/ha).

2.4.3 Effect of spacing and nitrogen

Vakeswaran and Vijayakumar (2005) observed the treatments with four spacing's (2.5, 5.0, 7.0 and 10 cm between plants and a uniform spacing of 40 cm between rows) and three levels of NPK fertilizers (80:60:50; 120:80:70 and 160:100:90 kg ha^{-1}) on seed crop of pea (*Pisum sativum L.*) cv. Bonneville. Observations made on number of seeds per pod were significantly influenced by spacing's and fertilizer levels.

Bokade (2008) studied that comparative effect of three levels of spacing's*viz,*60 ×120cm (S_1), 75×120cm (S_2), 90×120cm (S_2) and four levels of fertilizer *viz,*60:60:0 kg N/ha (T_1), 60:60:30 kg N/ha (T_2), 60:60:45 kg N/ha (T_3), 60:60:60 kg N/ha (T_4).

CHAPTER III

MATERIALS AND METHODS

The present investigation entitled, "Effect of spacings and fertilizers on growth, yield and quality of yard long bean (*Vignaunguiculata* sub sp. *Sesquipedalis*) var. 'Konkan Wali' grown under Konkan agroclimatic conditions of Maharashtra" was carried out during *rabi* season of the year 2015-2016. The details of experimental site, environmental conditions, materials used and methods followed are included in this chapter.

1.**Experimental site**

The present investigation was conducted at Hi-tech unit, Department of Horticulture, College of Agriculture, Dapoli, and Dist. Ratnagiri during *Rabi* season, 2015-2016.

1.1 **Soil characteristics**

The experimental plot was having lateritic loamy soil with uniform depth and good drainage. The selection of the site was done on the basis of suitability of land for cultivation of yard long bean.The selected land was well drained.

1.**Climate and weather conditions**

Dapoli is situated on West Coast of Maharashtra at an altitude of 280 meters above MSL. Its position on the world map is 17^0 45' North latitude and $73^0$12' East longitude. The average minimum and maximum temperatures recorded during 2015-2016 were 15.6ºc and 32.8ºc respectively. The average annual rainfall received during 2015-2016 was 3500 mm, normally distributed from June to October. Mean relative humidity was 73.78 per cent during the period of experiment. The relevant meteorological observations during the period of experimentation i.e. January,2015 to July,2016 were recorded and are presented in Appendix-II.

1.**Experimental design**

The experiment was laid out in Split Plot Design with nine combinations replicated thrice.

3.1**Experimental details**

1) Crop : Yard Long Bean (*Vignaunguiculata*)

2) Cultivar :Konkan Wali

3) Design :Split plot design

4) Replications : Three

5) No.of Treatment combinations: Nine Combinations

3.2 **Treatment details**

a) Main plot treatment (Spacing)

1) S_1: 90 × 30 cm

2) S_2: 90 × 60 cm

3) S_3:90 × 90 cm

b) Sub plot treatment (Fertilizer)

1) F_1: 60 kg N/ha

2) F_2: 90 kg N/ha

3) F_3: 120 kg /ha

3.3 **Source of seed material**

The certified seeds of yard long bean of variety Konkan wali was taken from vegetable improvement scheme, central Experiment Station, Wakawali Tal-Dapoli, Dist.Ratnagiri.

3.4 **Experimental area**

The Details regarding plot size, Number of plots, Net area is as under:

Plot Size :3.6 × 2.7 m

Total no. of Plots : 27

Total experimental Area: 409.76 m^2.

3.5 **Details of cultural operations**

3.5.1 **Preparation of land**

The soil of experimental plot was brought into fine tilth by criss-cross ploughing, three harrowing followed by levelling. The plot of size 3.6 × 2.7 m was prepared as per the plot layout. The sowing was done on flat bed at the spacing 0.9 × 0.6 m as per treatment details.

In between two replications the additional spacing of 2m was maintained to avoid the uptake of nutrient from adjacent blocks.

3.5.2 **Application of manures and fertilizers**

After preparation of land, protomeal @ 5 tons per hectore was incorporated in the soil.A basal fertilizer dose of 30 kg nitrogen, 60 kg phosphorous and 30 kg potash per hectore was applied through suphala and single super phosphate. The spot application of required fertilizer doses as per treatment details was done such as F_1 = 60:60:30 kg NPK/ha, F_2= 90:60:30 kg NPK/ha,F_3 = 120:60:30 kg NPK/ha.The remaining dose of nitrogen was applied in two splits i.e. 30 and 60 days after sowing as per treatment details through urea. Drenching of carbendazim @ 2g per litre 15 days after sowing was done.Drenching of copper oxy chloride @ 2g per litre 45 days after sowing was done.

3.5.3 **Sowing**

Three seeds were dibbled at each spot at required spacing treatments as per various spacing treatments.The depth of Spacing was 2-3 cm.

3.5.4 **Irrigation**

Plants were irrigated at an interval of one day with drip irrigation.

3.5.5 **Gap filling**

Gap filling was carried out on 10th day after sowing of seeds, where ever seeds were not germinated.

3.5.6 **Weeding**

Weeding was done manually.In all, two weeding's were done at 15 and 30 days after sowing. It was then followed by mulching with black polythene, so as to suppress weeds and to ensure weed free condition during subsequent growing period.

3.5.7 **Staking**

Yard long bean has indeterminate growth habit and require support for its healthy growth. Hence, each plant was staked with a tall dry bamboo tips when plant were of two or three weeksage. The vines were trailed on these standard. Necessary care was taken so that vines will not get mixed with vines of another plot.

3.5.8 **Plant protection measures**

Plant protection measures were followed as a preventive measure to keep the plant free from insect, pest and diseases.

Spraying of dichlorovas @ 1 ml per litre was done to minimize the attack of leaf minor 20 days after sowing. Similarly, spraying of shikari @ 2ml per litre was done to control the attack of thrips45 days after sowing. Spraying of Imidocloprid @ 0.5ml per litre and spraying of Lamda @ 2ml per litre to control the attack of aphids at

60 and 90 days after sowing. However, the spraying of chemicals was preferably avoided during the harvesting period.

3.5.9 **Harvesting**

The pods were harvested at full grown but tender stage suitable for vegetable purpose. The care was taken to harvest the pods before they mature and become fibrous. The hand pickings were done at an interval of 4 days.

3.6 **Observations recorded**

3.6.1 **Sampling technique.**

Five plants per treatment per replication were randomly selected and labelled for recording observations under study. The mean values of observations recorded during investigation were calculated.

3.6.2 **Growth observations**

The various growth observations length of vine (cm), number of primary branches and number of leaves per plant were recorded at harvest. These growth observations were as under:

3.6.2.1 **Length of vine (cm)**

TheLength of vine was measured with meter tape from the base i.e. collar region to the growing tip in centimeter at harvest and average vine length was worked out.

3.6.2.2 Number of primary branches

Number of primary branches was counted and average of five plants was worked out.

3.6.2.3 **Number of nodes**

The number of nodes per vine werecounted and average was worked out.

3.6.2.4 **Internodal length (cm)**

The internodal length was calculated by dividing the vine length by number of nodes at harvest and average was worked out.

3.6.2.5 **Number of leaves**

The number of leaves were counted and average of it was calculated.

3.6.2.6 **Average leaf area (cm^2)**

Leaf area of randomly selected leaves was measured with the help of leaf area meter and average of it was calculated.

3.6.2.7 **Total leaf area (cm^2)**

Total leaf area was calculated by multiplying average leaf area with total number of leaves on the plant. Total leaf area was calculated by following formula:

Average leaf area × Total population of leaves on plant

3.6.3 **Flowering behavior**

The observation pertaining to number of days required to initiation flowering, Fifty percent flowering was recorded and average was worked out.

3.6.3.1 **Number of days for first flowering**

The days required from sowing till commencement of flowering were recorded.

3.6.3.2 **Number of days to fifty per cent flowering**

Number of days required for fifty percent flowering of plants from the date of sowing till flowering was recorded.

3.6.4 **Yield and yield attributing character**

3.6.4.1 **Days to first picking**

The days required from sowing to first harvest were counted in each plot and recorded.

3.6.4.2 **Days from flowering to harvesting**

The total number of days from flowering to harvest was counted in each plot and average was worked out.

3.6.4.3 **Number of pods per plant**

The number of pods per plant per harvest were counted and total was worked out for the five randomly selected plants and average was calculated.

3.6.4.4 **Number of picking**

Total number of pickings werecounted from commencement of harvesting to last harvesting.

3.6.4.5 **Duration of harvest**

The number of days taken from first harvest to last harvest were recorded in each treatment and replication.

3.6.4.6 **Pod yield per plant (g)**

The yield of green pods (g) from the five randomly selected plants per treatment per replication was recorded and the average yield per plant was worked out.

3.6.4.7 **Pod yield per plot (kg) and per hectare (t)**

The yield of green pods (kg) from each plot was recorded and yield per hectare was calculated.

3.6.5 **Qualitative Characters**

3.6.5.1 **Physical parameters**

3.6.5.1.1 **Length of pod**

The length of ten randomly selected pods per treatment per replication was recorded from the proximal end to distal end by scale as per treatment from each replication and average was worked out.

3.6.5.1.2 **Girth of pod (cm)**

The diameter of each selected pod was recorded at the upper middle and basal portion from ten randomly selected pods per treatment per replication.The average was worked out.

3.6.5.1.3**Number of seeds per pod**

The total number of seeds per pod were counted from ten randomly selected pods per treatment per replication and average was worked out.

3.6.5.1.4 **Weight of green pod (g)**

The weight of ten green pods per treatment per replication was recorded and average was worked out.

3.6.5.1.5 **Color of pod and seed**

The green pods were categorized based on the color variation as light green, green, dark green by visual observations. Similarly, seeds of dried pods were categorized based on color into very pale brown, light brown, brown, dark brown and black based on visual observations.

CHAPTER IV

RESULTS AND DISCUSSION

The present study entitled "effect of spacing and fertilizers on vegetative growth, yield and green pod quality of yard long bean (*Vignaunguiculata*sub sp. *sesquipedalis* (L.) Verdcourt) var. 'KonkanWali" was conducted during 2015-2016.The results obtained are presented and discussed under following sub headings.

4.1 Effect of spacing, nitrogen and their interactions on the vegetative growth:

4.1.1 Length of vine (cm)

The data regarding length of vine varied significantly among all the treatments under study and are presented in Table 1.

Table 1. Effect of spacing, nitrogen and their interactions on Length of vine (cm) of yard long bean Var. KonkanWali

Length of vine (cm)				
60 Days				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	281.80	244.73	287.33	**271.29**
N_2	236.40	259.40	272.87	**256.22**
N_3	270.60	259.47	273.87	**267.98**
MEAN	**262.93**	**254.53**	**278.02**	**265.16**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	1.78	6.99	
N	**NS**	4.33	-	
S X N	**SIG**	15.94	49.13	

Effect of spacing (S)

The data presented in Table 1, revealed that spacing significantly influenced the length of vine. At 60 DAS, significantly

the highest length of vine (278.02cm) was observed at a spacing of 90 × 90cm (S_3) and was superior over all other spacing levels.

Thus, length of vine was increased in spacing of 90 × 90cm (S_3).Further, the vine length of 263.93 cm was recorded in S_1 whereas lowest vine length was recorded in S_2 (254.33cm).

The trend for length of vine at 60 DAS in different spacing was as follows -

$$\underline{S_3 > S_1} > S_2$$

The highest vine length in wider spacing might be due to availability of more space in wider spacing.

Similarfindings in relation to length of vine were also observed by Satodiya*et al.*, (2010) in cowpea, Mahaldar (1986) and Sarvaiya*et al.*,(1993) in cowpea, Parameswari*et al.*,(2003) in pigeon pea,Bokade (2008) in Yard long bean, Pawar*et al.*,(2007), Singh and Behera (1999) and Chakravorty*et al.*,(2009) in French bean, Nersekar (2016) and Swain and Rath (2006) in yam bean, Sharma (1994) in spinach and Mohapatra (1998) in rice bean.

Effect of nitrogen (N)

The effect of nitrogen application on length of vine was found to be non-significant. Length of vine was minimum in N_2 treatment (90:60:30 kg NPK/ha) and maximum in N_1 treatment (60:60:30 kg NPK/ha).

The trend for length of vine at 60 DAS in different nitrogen levels was as follow -

$$N_1 > N_3 > N_2$$

The above findings are in conformity with the results obtained by Hasan *et al.*,(2010) in cowpea, Bokade (2008) in yard long bean,Mohopatra (1998) in rice bean, Swain and Rath (2006) in

yam bean, Verenkar (1985) in lentil, Rana and Singh (1998) and Kumar and Puri (2002) in French bean, Ram and Dixit (2001) in green gram.

Effect of Interaction (S×N)

The interactions effect of spacing and nitrogen levels was also foundsignificant for length of vine. Among the various treatment combinations, the interaction S_3N_1 recorded significantly the highest length of vine (287.33 cm), while lowest vine length (236.40 cm) was recorded in the interaction S_1N_2. Further, it was observed that treatment S_1N_1 was at par with all other treatment combinations except S_1N_2.

It is evident from the data that all treatment combinations exhibited non-significant difference except S_1N_2 which might be due to maximum genetic potential of the genotype which was expressed in all treatment combinations except S_1N_2.

The trend for length of vine at 60 DAS in interaction was as follow –

$$\mathbf{S_3N_1 > S_1N_1 > S_3N_3 > S_3N_2 > S_1N_3 > S_2N_3 > S_2N_2 > S_2N_1 > S_1N_2}$$

The above findings are similar to the results reported by Vakeswaran and Vijayakumarn (2005) in Pea, Swain and Rath (2006) in yambean, Bokade (2008) in yard long bean, Mahaldar(1986) in cowpea,Chatterjee and Som (1991) in French bean.

4.1.2**Number of branches per plant**

The data pertaining to effect of spacing, nitrogen and their interactions on number of primary branches are presented in Table 2 and illustrated in Fig. 2

Table 2. Effect of spacing, nitrogen and their interactions on number of branches per plant of yard long bean Var.KonkanWali

No. of primary branches								
	60 Days				120 Days			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
N_1	16.20	19.27	14.20	**16.56**	41.87	37.27	42.40	**40.51**
N_2	14.60	20.53	11.33	**15.49**	40.33	55.27	39.00	**44.87**
N_3	15.67	13.67	12.93	**14.09**	49.07	45.27	58.60	**50.98**
MEAN	**15.49**	**17.82**	**12.82**	**15.38**	**43.76**	**45.93**	**46.67**	**45.45**
	RESULT	**SEM±**	**CD@5%**		**RESULT**	**SEM±**	**CD@5%**	
S	**SIG**	0.08	0.34		**SIG**	0.21	0.84	
N	**SIG**	0.12	0.39		**SIG**	0.20	0.62	
S X N	**SIG**	2.39	7.38		**SIG**	8.05	24.82	

Effect of spacing (S)

The spacing levels exhibited a significant effect on number of branches per plant (Table 2).At 60 DAS, the data regarding number of primary branches ranged from 12.82 to 17.82 with mean 15.38. The medium spacing (S_2) recorded significantly the highest number of branches (17.82) per plant and was found superior over S_3 but was at par with S_1.The treatment S_1 and S_2 recorded higher values as compared to mean.

The spacing levels showed a significant effect on number of primary branches per plant at 120 DAS also (Table 2).

The number of primary branches from 43.76 to 46.67 with mean 45.45. The wider spacing (S_3) 90 × 90 cm, recorded significantly the highest number of primary branches (46.67) per plant and was found at par with S_1 and S_2.The treatment S_2 (90 ×

60 cm) and (S_3) 90 × 90 cm recorded highest values as compared to mean.

The trend of number of branches per plant due to various spacing was as follows:

$$\mathbf{S_3 < S_2 < S_1}$$

Increase in number of branches per plant at medium and wider spacing might be due to optimum space for horizontal expansion and less competition for nutrients which led to development of more number of branches.

Above findings are similar conclusion to that ofSarvaiya*et al.*, (1993) in Cowpea, Bokade (2008) in Yard long bean, Parameswari*et al.*, (2003) in pigeon pea, Chatterjee and som (1991) in French bean, Mohapatra (1998) also noticed the significant effect on number of primary branches per plant.

Effect of nitrogen (N)

Various nitrogen doses also recorded significant effect on number of primary branches at 60 DAS. Significantly the highest number of branches per plant (16.56) were recorded at N_1 treatment (60:60:30 kg NPK/ha) and was at par with N_2 but was superior over N_3. The lowest number of branches per plant (14.09) were observed in N_3 treatment.

At 120 DAS,significant effect on number of primary branches per plant was recorded. Significantly highest number of branches per plant (50.98) were recorded in N_3 treatment (120:60:30 kg NPK/ha) which was superior over N_1 and N_2 treatments.

The trend for number of primary branches affected in various nitrogen treatments was as follows:

$$\mathbf{N_3 > N_2 < N_1}$$

It was also observed that at 60 DAS, the lowest number of primary branches were recorded in N_3. Whereas at 120 DAS, the number of primary branches recorded in N_3 were highest as compared to N_1 and N_2 which might be due to the availability of nutrients throughout the growing span which has increased the number of primary branches after 60 DAS.

The above findings are well in line with the results reported by Hasan *et al.*, (2010) and Sarvaiya*et al.*, (1993) in Cowpea, Verenkar (1985) in lentil, Mohopatra (1988) in Rice bean, Bokade (2008) in Yard long bean, Chaterjee and Som (1991) in French bean,Parameswari*et al.*, (2003) in pigeon pea.

Interaction Effect (S×N)

The number of primary branches at 60 DAS, ranged from 11.33 to 20.53 with the mean of 53.38.The treatment combination S_2N_2 was significantly superior (20.53) over all other interactions except S_2N_1, S_1N_1, S_1N_3. Further, significantly lowest number of branches (11.33) per plant were noticed in treatment combination of S_3N_2 (11.33). Above population mean (15.38) S_2N_1 (19.27), S_1N_1 (16.20) and S_1N_3 (15.67) recorded higher values for number of branches per plant.

In interaction effect at 120 DAS, number of primary branches ranged from 37.27 to 58.60 with the mean of 45.45, the treatment S_3F_3 was significantly superior (58.60) over all other treatment combinations except S_1N_3 (49.07), S_2N_2(55.27). Further, significantly lowest number of branches (37.27) per plant were noticed under the interaction of S_2N_1.

The trend for length of vine at 60 DAS in different nitrogen levels was as follow –

S_3N_3>S_2N_2>S_1N_3>S_2N_3>S_3N_1>S_1N_1>S_1N_2>S_3N_2>S_2N_1

The availability of more space as well as more nutrient in S_3N_3 might have increased the number of primary branches as compared to other treatment combinations.

Bokade (2008) in yard long bean, Mahaldar (1986) in cowpea and Chatterjee and Som (1991) in French bean also noticed similar interaction effect on number of primary branches per plant.

4.1.3 **Number of nodes**

The data regarding effect of spacing, nitrogen levels and their interactions in relation to number of nodes per plant are presented in Table 3 and illustrated in Fig. 3

Effect of spacing

From the data presented in Table 3, it is clear that spacing significantly influenced the number of nodes at 60 DAS. Significantly highest number of nodes per plant (75.58) were observed in S_2 (90 × 60cm) and was significantly superior over all other spacing levels.

Bokade (2008) in Yard long beanrecorded non-significant effect on number of nodes.

However, at 120 DAS, significant effect on number of nodes was observed significantly.The highest number of nodes (283.70) were observed in S_2 (90 × 60cm) which was superior over all other spacing levels. Number of nodes was increased upto medium spacing S_2 (90 × 60cm) and then decreased at lowest spacing S_1(90 × 90cm).The trend of number of nodes in various spacing's at 120 DAS was as follows:

$$\mathbf{S_2 > S_3 > S_1}$$

Bokade (2008) in yard long bean showed non-significant effect on number of nodes.

Table 3. Effect of spacing, nitrogen and their interactions on number of nodes per plant of yard long bean Var. KonkanWali

No. of Nodes								
	60 Days				120 Days			
	S_1	S_2	S_3	MEAN	S_1	S_2	S_3	MEAN
N_1	64.67	82.67	76.33	**74.56**	238.33	301.3	268.40	**269.36**
N_2	91.60	94.67	66.13	**84.13**	262.13	250.2	184.40	**232.24**
N_3	52.20	49.40	61.93	**54.51**	211.67	299.8	316.40	**275.96**
MEAN	**69.49**	**75.58**	**68.13**	**71.06**	**237.38**	**283.7**	**256.40**	**259.18**
	RESULT	**SEM±**	**CD@5%**		**RESULT**	**SEM±**	**CD@5%**	
S	**SIG**	0.32	1.2942		**SIG**	0.38	1.50	
N	**SIG**	0.35	1.0798		**SIG**	0.58	1.81	
SXN	**SIG**	12.74	39.26		**SIG**	46.2	142.57	

Effect of nitrogen

Variousnitrogen levels also exhibited significant effect on number of nodes per plant at 60 DAS. Highest number of nodes (84.13) were observed in N_2 (90:60:30 kg NPK/ha) which was significantly superior over N_2 and N_3.

At 120 DAS, the nitrogen levels showed a significant effect on number of nodes. Significantly highest number of nodes (275.96) were observed at N_3 (120:60:30kg NPK/ha) and was significantly superior over N_1 (60:60:30kg NPK/ha) and N_2 (90:60:30kg NPK/ha).Thus, it is clear from the data that number of nodes increased with increasing level of nitrogen. The trend of number of nodes per plant in different nitrogen levels was as follows:

$$\mathbf{N_3 > N_1 > N_2}$$

Bokade (2008) in Yard long beanrecorded non-significant effect on number of nodes.

Effect of Interaction

The interaction effect between spacing and nitrogen on number of nodes per plant was found significant at 60 DAS. Significantly highest number of nodes per plant (94.67) were recorded at the interaction S_2N_2 and was significantly superior over all other interactions except S_1N_2 (91.60).

The interaction effect between spacing and nitrogen on number of nodes per plant was found significant at 120 DAS. Significantly highest number of nodes per plant (316.40) were recorded in treatment combination S_3N_3 and was significantly superior over all other interactions except S_2N_1 (301.3).

The trend of number of nodes produced in various treatment combinations at 120 DAS was as follows:

S_3N_3>S_2N_1>S_2N_3> S_3N_1> S_1N_2> S_2N_2> S_1N_1> S_1N_3> S_3N_3

The more number of nodes per plant in S_3N_3 might be due to availability of more spacing and nutrient in S_3N_3 which resulted into more vegetative growth.

Bokade (2008) in Yard long beanreported similar result.

4.1.4 **Internodal length**

Data regarding internodal length as influenced by different treatments are presented in Table 4.

Effect of spacing

The critical perusal of data presented in Table 4 revealed significant effect of spacing on internodal length.

Significantly, the highest internodal length at 60 DAS (14.80cm) was observed at S_2 (90 × 60cm)which was superior over all other spacing levels i.e. S_1 (11.32cm) and S_3 (13.74cm).

From the data presented in Table 4, it is clear that spacing has significantly influenced the internodal length at 120 DAS. Significantly the highest internodal length (22.42cm) was observed in S_1 (90 × 30cm) which was significantly superior over all other spacing levels i.e. S_2 (90 × 60cm) S_3 (90 × 90cm).

The trend of internodal length in various spacing at 120 DAS was as follows:

$S_1 > S_3 > S_2$

In closer spacing plants are compact with less penetration of sunlight as compared to wider spacing which might have increased the intermodal length in S_1.

Table 4. Effect of spacing, nitrogenand their interactions on internodal length of yard long bean Var. KonkanWali

Internodal length								
	60 Days				**120 Days**			
	S_1	**S_2**	**S_3**	**MEAN**	**S_1**	**S_2**	**S_3**	**MEAN**
N_1	12.49	14.09	11.29	**12.62**	24.38	23.67	18.62	**22.22**
N_2	10.73	17.71	14.02	**14.15**	21.50	17.01	20.59	**19.70**
N_3	10.75	12.60	15.92	**13.09**	21.38	18.75	22.11	**20.74**
MEAN	**11.32**	**14.80**	**13.74**	**13.28**	**22.42**	**19.81**	**20.44**	**20.88**
	RESULT	**SEM±**	**CD@5%**		**RESULT**	**SEM±**	**CD@5%**	
S	**SIG**	0.26	1.02		**SIG**	0.17	0.66	
N	**SIG**	0.29	0.92		**SIG**	0.18	0.55	
S X N	**SIG**	2.39	7.39		**SIG**	2.55	7.86	

Effect of Nitrogen

Various nitrogen levels also significantly influenced the internodal length at 60 DAS.The treatment N_2(90:60:30kg NPK/ha) recorded significantly highest internodal length (14.15 cm) as compared to N_1 (60:60:30kg NPK/ha) and N_3 (60:60:30kg NPK/ha)

At 120 DAS, N_1(60:60:30kg NPK/ha) recorded highest internodal length (22.22cm) as compared to other treatments.

The trend of internodal length in various nitrogen doses was as follows:

$N_1 > N_3 > N_2$

Effect of Interaction

Interaction of spacing and nitrogen at 60 DAS significantly highest internodal length (17.71cm) was recorded in S_2N_2 which was significantly superior over all other interactions except S_3N_3 (15.92cm), S_3N_2 (14.02cm), S_2N_1 (14.09cm) interactions.

However, interaction effect between spacing and nitrogen on internodal length was found to be significant at 120 DAS. However, significantly highest internodal length (24.38cm) was recorded in treatment combination S_1N_1 which was at par with all the treatments.

The trend of number of nodes produced in various treatment combinations at 120 DAS was as follows:

$S_1N_1 > S_2N_1 > S_3N_3 > S_1N_2 > S_1N_3 > S_3N_2 > S_2N_3 > S_3N_1 > S_2N_2$

4.1.5 **Number of leaves per plant**

The data pertaining to number of leaves per plant as influenced by various spacing's (S), various nitrogen levels (N), and their interaction (S×N) are presented in Table 5 and illustrated in Fig. 4

Table 5. Effect of spacing, nitrogen and their interactions on numberof leaves per plant of yard long bean Var. KonkanWali

	No. of Leaves	
	60 Days	**120 Days**

	S_1	S_2	S_3	mean	S_1	S_2	S_3	Mean
N_1	104.20	76.53	81.47	**87.40**	325.33	314.40	255.87	**298.53**
N_2	106.57	109.80	77.67	**98.01**	243.73	377.67	298.73	**306.71**
N_3	63.47	56.07	47.27	**55.60**	223.93	199.87	265.60	**278.26**
Mean	**91.41**	**80.80**	**68.80**	**80.33**	**264.33**	**297.31**	**273.40**	**294.50**
	RESULT	**SEM±**	**CD@5%**		**RESULT**	**SEM±**	**CD@5%**	
S	**SIG**	2.18	8.57		**SIG**	4.75	18.68	
N	**SIG**	1.09	3.36		**SIG**	4.36	13.43	
S × N	**SIG**	10.81	33.31		**SIG**	55.51	171.04	

Effect of spacing

The critical perusal of data presented in Table 5 revealed that at 60 DAS, maximum number of leaves (91.41) were produced in S_1 which was significantly superior over S_2 (80.80) and S_3 (68.80).Thus, it indicated that number of leaves goes on the decreasing with increase in the spacing.

At 120 DAS, the maximum number of leaves per plant were produced in S_3 (297.31) which was significantly superior over S_1 (264.33) as well as S_2 (273.40).However, the difference among S_1 and S_2 was non-significant.

The trend of number of leaves per plant in various spacing at 120 DAS was as follows:

S_3>S_2>S_1

The higher number of leaves reported in wider spacing at 120 DAS might be due to availability of more space for the plant in S_3 which has allowed the plant to grow to its full potential.

The similar results were also reported by Adigun *et al.*, (2014)in cowpea, Bokade (2008) in yard long bean, Pawar*et al.*,(2007),Chakravarty *et al.*, (2009),and Singh and Behera (1999) in French bean and Nersekar (2016) in yambean.

Effect of nitrogen

Among the various nitrogen levels tried the maximum number of leaves at 60 DAS were reported in N_2 (98.01) which was significantly superior over N_1 (87.40) and N_3 (47.27).The lowest number of leaves were recorded in N_3.

At 120 DAS, the maximum number of leaves (306.71) were also produced in N_2.However it was at par with the number of leaves produced in N_1 (298.53) the lowest number of leaves were produced in N_3 (278.26) and was significantly inferior to N_1 and N_2.

The higher number of leaves were produced in lowernitrogen dose (N_1 and N_2) as compared to higher nitrogen dose (N_3).This might be due to the favorable micro-climate available in the plot of closer spacing which resulted in increasing the number of leaves in N_1 and N_2.

The trend of number of leavesper plant at 120 DAS was as follows:

$$\underline{N_2 > N_1} > N_3$$

However, the significant results were reported by Verenkar (1985) in kulthi, Saxena and Verma (1995) Rana and Singh (1998) and Singh and Behera (1999) in French bean and Ram and Dixit (2001) in green gram.

Effect of Interaction

The data pertaining to interaction effect of spacing and nitrogen in various treatment combinations on number of leaves are presented in Table 5.The data revealed that at 60 DAS, the maximum number of leaves were recorded in S_2N_2which was at par with all other treatment combinations exceptS_2N_3(56.07).The lowest number of leaves were produced in S_3N_3.

At 120 DAS, the maximum number of leaves were produced in S_2N_2 (377.67) which was at par with all the treatments except S_2N_3 (199.87) which produced the lowest number of leaves per plant.

Thus, it is evident that the treatment combination having closer spacing produced more number of leaves as compared to wider spacing.This might be due to favorable micro-climate available in the plot of closer spacing.

The trend of number of leaves produced in various treatment combinations was as follows:

S_2N_2>S_1N_1>S_2N_1> S_3N_2> S_3N_3> S_3N_1> S_1N_2> S_1N_3> S_2N_3

Similarly significant results were also recorded by Bokade (2008) in yard long bean and Mahaldar (1986) in cowpea.

4.1.6 **Average leaf area (cm^2)**

Leaf area is an important attribute as it has direct relationship with interception of light for photosynthesis. The data regarding to average leaf area per plant are presented in Table 6.

Effect of spacing

In the present study, at 60 DAS, the average leaf area of yard long bean was found to be non-significant under different spacing levels. However, the highest average leaf area (123.39cm^2) was noticed in spacing S_2 (90×60cm), followed by spacing S_3 (90×90cm) (123.02cm^2) and spacing S_1 of (90×30cm) (104.88cm^2).

At 120 DAS the average leaf area of yard long bean was also found to be non-significant under different spacing levels. However, the highest average leaf area (130.69cm^2) was noticed in spacing S_3(90×90 cm).

The trend of average leaf area in various spacing at 120 DAS was as follows:

$S_3 > S_2 > S_1$

However, the significant results were reported by Adigun *et al.*, (2014) in cowpea, Bokade (2008) in yard long bean, Pawar*et al.*, (2007) in French bean.

Table 6. Effect of spacing, nitrogen and their interactions on average leaf area (cm^2) of yard long bean Var. KonkanWali

Average leaf area(cm^2)								
	60 Days				120 Days			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
N_1	111.49	113.02	113.91	**112.81**	130.80	113.91	126.75	**123.82**
N_2	89.03	133.44	119.94	**114.14**	110.77	124.38	147.35	**127.50**
N_3	114.12	123.70	135.20	**124.34**	138.58	141.98	117.97	**132.84**
Mean	**104.88**	**123.39**	**123.02**	**117.09**	**126.72**	**126.76**	**130.69**	**128.05**
	RESULT	**SEM±**	**CD@5%**		**RESULT**	**SEM±**	**CD@5%**	
S	**NS**	4.15	-		**NS**	9.38	-	
N	**NS**	6.44	-		**NS**	6.11	-	
S X N	**NS**	12.15	-		**NS**	16.92	-	

Effect of nitrogen

At 60 DAS the average leaf area of yard long bean was found to be non-significant under different treatment combinations. However, the maximum average leaf area (124.34 cm^2) was noticed in N_3 treatment (120:60:30 kg NPK/ha).

The average leaf area of yard long bean was found to be non-significant under different treatment combinations at 120 DAS. However, the maximum average leaf area (132.84 cm^2) was noticed in N_3 treatment (120:60:30 kg NPK/ha).

The trend of average leaf area in various nitrogen levels at 120 DAS was as follows:

$N_3 > N_2 > N_1$

The present research findings are in conformation with those of Bokade (2008) in yard long bean, Saxena and Verma (1995) and Rana and Singh (1998) in French bean.

Effect of Interaction

The interaction effect on average leaf area at 60 DAS was found to be non-significant. However, the S_3N_3 recorded the highest average leaf area (135.20 cm^2).It was superior over S_1N_1, S_2N_1, S_3N_1, S_1N_2, S_3N_2, S_1N_3.

At 120 DAS the interaction effect on average leaf area was found to be non-significant. However, the S_3N_2 recorded the highest average leaf area (147.35 cm^2)

Similar result was reported by Bokade (2008) in yard long bean.

4.1.7**Total leaf area (cm^2)**

The data pertaining to the effect of spacing, nitrogen levels and their interaction on total leaf area of yard long bean are presented in Table 7.

Effect of spacing

Thecritical perusal of data presented in Table 7 revealed that at 60 DAS, highest total leaf area (10081.12 cm^2) was produced in S_2which was significantly superior over S_1 (6562.92 cm^2) and S_3 (8124.07 cm^2).Thus, it indicated that wider spacing in S_2produced highest total leaf area.

At 120 DAS, highest total leaf area (23597.09 cm^2) was produced in S_2which was significantly superior over S_1 (19967.75 cm^2) and S_3 (18805.53 cm^2). S_1 wasat par with S_3.

The trend of total leaf area in various spacing at 120 DAS was as follows:

S_2>S_1>S_3

The highest total leaf area reported in moderate spacing at 120 DAS might be due to sufficient availability of space for the plant. The above results are in conformity with the findings of Nersekar (2016) in yam bean.

Table 7. Effect of spacing, nitrogen and their interactions on total leaf area of yard long bean Var. KonkanWali

Total leaf area (cm^2)								
	60 Days				**120 Days**			
	S_1	**S_2**	**S_3**	**Mean**	**S_1**	**S_2**	**S_3**	**Mean**
N_1	5818.81	10682.51	9122.65	**8541.32**	12535.88	18842.49	9917.9	**13765.4**
N_2	6433.23	11244.58	8487.33	**8721.71**	22655.02	26832.73	20397.9	**23295.2**
N_3	7436.73	8316.28	8562.23	**8105.08**	24712.36	25116.05	26109.6	**25312.7**
Mean	**6562.92**	**10081.12**	**8724.07**	**8456.03**	**19967.75**	**23597.09**	**18808.5**	20791.1
	RESULT	**SEM±**	**CD@5%**		**RESULT**	**SEM±**	**CD@5%**	
S	**SIG**	82.51	324.00		**SIG**	305.11	1198.01	
N	**NS**	164.84	-		**SIG**	241.27	743.45	
S X N	**SIG**	1204.37	3711.04		**SIG**	2597.95	8005.08	

Effect of nitrogen

Among the various nitrogen levels, the highest total leaf area at 60 DAS was reported in N_2 (8721.71 cm^2) which was significantly superior over N_1 (8541.32 cm^2) and N_3 (8105.08 cm^2).The lowest total leaf area was recorded in N_3.

At 120 DAS the highest total leaf area (25312.70 cm^2) was also produced byN_3 while lowest (13765.5 cm^2) in N_1 treatment (60:60:30kg NPK/ha). However, the total leaf area increased with increasing levels of nitrogen.

The trend of total leaf area in various treatment combinations at 120 DAS was as follows:

$$\underline{N_3>N_2>N_1}$$

The results indicated that there was an increase in the total leaf area with increase in nitrogen doses which might be due to availability of more nutrients for each plant in higher spacing.

Effect of Interaction

The interaction effect of S_2N_2 was significantly superior over all other interactions at 60 DAS, was recorded highest Total leaf area (11244.58 cm^2) per plant was at par with S_2N_1, S_2N_3, S_3N_1, S_3N_2 and S_3N_3. Significantly lowest (5818.81 cm^2) total leaf area was observed at S_1N_1 treatment combination.

The interaction effect of S_2N_2 was significantly superior over all other interactions at 120 DAS and recorded highest Total leaf area (26832.73 cm^2) per plant and was at par with S_2N_1, S_1N_2, S_1N_3, S_2N_3 S_3N_2 and S_3N11_3. Significantly, lowest total leaf area (9917.99 cm^2) was observed in S_3N_1 treatment.

The trend of total leaf area in various treatment combinations at 120 DAS was as follows:

$$\mathbf{S_2N_2>\underline{S_3N_3 >S_2N_3 >S_1N_3 >S_1N_2 >S_3N_2>S_2N_1}>S_1N_1>S_3N_1}$$

During the present investigation, increase in the total leaf area in the spacing and nitrogen levels might be due to availability of more space and nutrition which resulted in extension of life cycle. The similar results were also reported by Nersekar (2016) in yam bean.

4.2 Effect of spacing, nitrogen and their interactions on the flowering behavior

4.2.1 Number of days to first flowering

The data pertaining to the number of days to first flowering are presented in Table 8 and illustrated in Fig.5which revealed that spacing levels and interaction between spacing and nitrogen significantly varied for days to first flowering.

Table 8. Effect of spacing, nitrogen and their interaction on number of days for first flowering of yard long bean Var. KonkanWali

No. of days to first flowering				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	70.67	73.20	69.73	**71.20**
N_2	69.87	71.40	70.80	**70.69**
N_3	72.27	71.13	70.27	**71.22**
MEAN	**70.93**	**71.91**	**70.27**	**71.03**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.05	0.20	
N	**NS**	0.24	-	
S X N	**SIG**	1.17	3.62	

Effect of spacing

Different spacing levels exhibited significant effect on number of days taken to first flowering. The days taken for first flowering ranged 70.27 to 71.91 days with mean of 71.03 days. Significantly the earliest flowering (70.27 days) was recorded under the spacing S_3(90×90cm), while spacing S_2 (90×60cm), showed significantly more days (71.91 days).There was increase in days required for initiation of first flower with decrease in spacing.

The trend of effect of spacing on number of days to first flowering was as follows:

$$\underline{S_2 > S_1} > S_3$$

Effect of nitrogen

The various nitrogen doses tried under present investigation exhibited non-significant effect on number of days to first flowering. The lowest number of days to first flowering(70.69 days) was recorded by the treatment N_2 (90:60:30 kg NPK/ha) while more number of days (71.22 days) for first flowering was noticed in N_3 (120:60:30 kg NPK/ha).

The trend of effect of nitrogen on number of days to first flowering was as follows:

$$\mathbf{N_3 > N_1 > N_2}$$

Effect of Interaction

Interaction effect between spacing and nitrogen was found to be significant with respect to number of days for first flowering (Table 8). More number of days (73.20 days) taken for first flowering was observed in S_2N_1 and S_2N_3 while less number of days (69.73 days) were recorded in S_3N_2 and S_3N_1.The treatment combination S_2N_1 was at par with all treatments i.e. S_1N_1,S_1N_2,S_1N_3, S_2N_2, S_2N_3, S_3N_1 S_3N_2 and S_3N_3.

The trend of various treatment combination on number of days to first flowering was as follows:

$$\mathbf{S_2N_1 > S_1N_3 > S_2N_2 > S_2N_3 > S_3N_2 > S_1N_1 > S_3N_3 > S_1N_2 > S_3N_1}$$

4.2.2 **Number of days to fifty per cent flowering**

The data pertaining to the number of days for fifty per cent flowering are presented in Table 9the data revealed that interaction between spacing and nitrogen significantly varied for days for fifty per cent flowering.

Table 9. Effect of spacing, nitrogen and their interaction on number of days for 50% flowering of yard long bean Var. KonkanWali

No. of days to 50% flowering				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	78.60	75.73	74.00	**76.11**
N_2	76.67	75.80	76.40	**76.29**
N_3	73.40	76.93	79.33	**76.56**
MEAN	**76.22**	**76.16**	**76.58**	**76.32**
	RESULT	**SEM±**	**CD@5%**	
S	**NS**	0.36	-	
N	**NS**	0.21	-	
S X N	**SIG**	2.67	8.25	

Effect of spacing

The critical perusal of data presented in Table.9 revealed that the effect of different spacing levels on number of days for fifty per cent flowering was found non-significant. Less number of days (76.16 days) were recorded by spacing level S_2 (90×60cm), while more number of days were recorded by S_3 (90×90cm).

The trend of effect of spacing on number of days for fifty per cent flowering was as follows:

$S_3 > S_1 > S_2$

The more number of days to fifty per cent flowering reported in wider spacing might be due to availability of water, nutrient and

more space for the plant in S_3 which has allowed the plant to grow with its full potential.

Bokade (2008) in yard log bean reported non-significant results and significant results were reported by Maya *et al.*, (1997) in capsicum for number of days for fifty per cent flowering.

Effect of nitrogen

Effect of various nitrogen levels tried under present investigation observed non-significant differences with respect to number of days for fifty per cent flowering.Less number of days (76.11days) were recorded by the treatment N_1 (60:60:30kg NPK/ha), while more number of days (76.56days) for fifty per cent flowering were noticed in N_3 treatment (120:60:30kgNPK/ha).

The trend of effect of nitrogen on number of days for fifty per cent flowering was as follows:

$$\mathbf{N_3 > N_2 > N_1}$$

Days to fifty per cent flowering in yard long bean is an important character which decides the earliness. Increase in fifty per cent flowering might be due to increase in nitrogen doses.

The similar results were also obtained by Praseeda (1978) in tomato and Krishnamurthy and Rao (1984) in black gram and green gram.

Effect of interaction

The Interaction of spacing and nitrogen levels on number of days for fifty per cent flowering showed non-significant differences among the various treatment combinations (Table 8).Less number of days (73.40 days) taken for fifty per cent flowering were observed in S_1N_3 while more number of days (79.33 days) were recorded at S_3N_3.

The trend of effect of nitrogenlevels on number of days for fifty per cent flowering was as follows:

$$\underline{S_3N_3>S_1N_1>S_2N_3>S_1N_2>S_3N_2>S_2N_2>S_2N_1>S_3N_1>S_1N_3}$$

It is evident from data that the treatment combination having wider spacing required more number of days to fifty per cent flowering which might be due to favorable micro-climate available in the plots. Bokade (2008) in yard long bean found non-significant results for number of days for fifty per cent flowering.

4.3 Effect of spacing, nitrogen and their interactions on yield and yield attributing character

4.3.1 Days to first picking

The data pertaining to days to first picking as influenced by various spacing (S), various nitrogen levels (N) and their interaction (S×N) are presented in Table 10 and illustrated in Fig. 6

Effect of spacing

Effect of various spacing tried under study showed significant effect on days to first picking of yard long bean are presented in Table 10.Lowest days to first picking were recorded in S_1 (85.42 days) whereas the highest number of days required to first picking were recorded in S_2 (87.31 days) which is significantly inferior over S_1 (85.42days) and S_3 (85.56days).Thus, it is clear from the data that days to first picking increased with increase in spacing.

The trend of effect of spacing on days to first picking was as follows:

$$\underline{S_2>S_3}>S_1$$

Bokade (2008) in yard long bean also recorded non-significant results for days to first picking.

Table 10. Effect of spacing, nitrogen and their interactions on days to first picking of yard long bean Var. KonkanWali

Days to first picking				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	85.20	85.87	85.13	**85.40**
N_2	83.07	87.40	83.27	**84.58**
N_3	88.00	88.67	88.27	**88.31**
MEAN	**85.42**	**87.31**	**85.56**	**86.09**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.25	1.01	
N	**SIG**	0.30	0.94	
S X N	**SIG**	1.20	3.72	

Effect of nitrogen

Among the various nitrogen doses tried significant effect on the days to first picking was recorded and the data regarding it are presented in Table 10. The lowest number of days to first picking was recorded in N_2 (84.58 days) and was significantly inferior to N_1(85.40days) and N_3 (88.31days).

The trend of effect of various nitrogen levels on days to first picking was as follows:

$$N_3 > \underline{N_1 > N_2}$$

Bokade (2008) in yard long bean showed non-significant effect on days to first picking.

Effect of Interaction

The data pertaining to interaction effect of spacing and nitrogen in various treatment combinations on days to first picking are presented in Table 10. The data revealed that the lowest number of days (83.07 days) for first picking were recorded in S_1N_2, leading

to the earliest harvest. Significantly, more number of days (88.67 days) were recorded S_2N_3.Further, it was noticed that it was at par with S_1N_1, S_2N_1, S_3N_1, S_2N_2, S_1N_3 andS_3N_3.

The trend of effect of various nitrogen levels on days to first picking was as follows:

S_2N_3 > S_3N_3> S_1N_3 > S_2N_2 > S_2N_1 > S_1N_1 > S_3N_1> S_3N_2 > S_1N_2

It was observed from the data that days to first picking increased with increase in spacing as well as increase in nitrogen levels which in turn increases the vegetative growth and extended the juvenile phase.The similar results were also reported by Bokade (2008) in yard long bean.

4.3.2 **Days from first flowering to first harvest**

The data pertaining to days from first flowering to firstharvest as influenced by various spacing, nitrogen levels and their interactions are present in Table 11.

Table 11. Effect of spacing, nitrogen and their interactions on number of days from first flowering to first harvest of yard long bean Var. KonkanWali

Days from flowering to harvesting				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	11.87	13.73	12.27	**12.62**
N_2	11.87	14.33	13.80	**13.33**
N_3	13.00	10.20	11.93	**11.71**
MEAN	**12.24**	**12.76**	**12.67**	**12.55**
	RESULT	**SEM±**	**CD@5%**	
S	**NS**	0.26	-	
N	**SIG**	0.21	0.65	
SX N	**SIG**	1.48	4.58	

Effect of spacing

The critical perusal of data presented in Table 11 revealed non- significant effect of the various spacings tried on the days from flowering to harvesting. The highest number of days for flowering to harvesting were recorded in S_2 (12.76 days) which was significantly superior over S_1 (12.24 days) and S_3 (12.67 days).

The trend of effect of spacing on number of days from first flowering to harvesting was as follows:

$$\mathbf{S_2 > S_3 > S_1}$$

Similar result was found by Bokade (2008) in yard long bean.

Effect of nitrogen

The critical perusal of data presented in Table 11 revealed significant difference among the various nitrogen combinations tried the the maximum number of days from first flowering to harvesting were recorded in N_2 (13.33 days) which was superior over N_1(12.62 days) and N_3 (11.71 days).

The trend of effect of nitrogen on number of days from first flowering to harvesting was as follows:

$$\mathbf{\underline{N_2 > N_1} > N_3}$$

The higher number of days were observed in moderate nitrogen dose (N_2) as compared to lowest nitrogen dose (N_1) and high nitrogen dose (N_3). This might be due to the optimum nutrient requirement of the crop in N_2

Bokade (2008) in Yard long bean found non-significant effect on days from flowering to harvesting.

Effect of Interaction

The data pertaining to interaction effect of various treatment combinations on days from first flowering to first harvesting arepresented in Table 11 which was significant. The data revealed

that maximum days were recorded in S_2N_2 (14.33 day) which was at par with S_3N_2, S_2N_1 and S_1N_3.The lowest number of days were recorded in S_2N_3 (10.20 day).

The trend of effect of nitrogen on number of days from first flowering to harvesting was as follows:

S_2N_2 > S_3N_2>S_2N_1 >S_1N_3>S_3N_1> S_3N_3 >S_1N_2 >S_1N_1> S_2N_3

Days to first harvest were more in moderate spacing and in lesser nitrogen dose which might be due to more vegetative growth of plant in moderate spacing as compared to closer spacing.

Bokade (2008) in yard long bean showed non-significant effect on days from first flowering to first harvesting.

4.3.3**Number of pods per plant**

The data pertaining to the effect of spacing, nitrogen levels and their interactions on number of pods per plant are presented in Table 12 and illustrated in Fig. 7

Table 12. Effect of spacing, nitrogen and their interaction on number of pods per plant of yard long bean Var. Konkanwali

No. of pods per plant				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	2186.20	2239.87	1393.67	**1939.91**
N_2	1667.60	1902.27	1612.33	**1727.40**
N_3	2012.87	1441.73	1462.73	**1639.11**
MEAN	**1955.56**	**1861.29**	**1489.58**	**1768.80**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	14.67	57.60	
N	**SIG**	26.92	82.95	
S X N	**SIG**	292.39	900.95	

Effect of spacing

It is evident from the data that spacing had significant effect on number of pods per plant. The highest number of pods per plant was observed in S_1 (1955.56) which was significantly superior over S_2 (1861.29) and S_3 (1489.58) whereas, the lowest number of pods per plant were observed in S_3. Thus, more number of pods were harvested in S_1 as compared to S_2 and S_3.

The trend of effect of spacing on number of pods per plant was as follows

$$\mathbf{S_1 > S_2 > S_3}$$

Such effect in relation to number of pods per plant was also noticed by Joshi and Rahevar (2015) in Indian bean, Bokade (2008) in yard long bean, Sharma *et al* .,(2008) in French bean, Sarvaiya*et al.*,(1993) in pigeon pea, Bahadoria and Chauhan (1994) in cluster bean and Mohapatra (1998) in rice bean.

Effect of nitrogen

Effect of various nitrogen levels on number of pods per plant recorded significant difference. The highest number of pods per plant were observed in N_1 (1939.91) which was significantly superior over N_2 (1727.40) and N_3 (1639.11).

The trend of effect of various nitrogen levels on number of pods per plant was as follows:

$$\mathbf{N_1 > N_2 > N_3}$$

The highest number of pods were harvested from closer spacing N_1 this might be due to the highest plant population or nitrogen doses or favorable climate.

Similar findings in relation to effect of nitrogen on number of pods per plant were also observed by Mahaldar*et al.*,(1991) in cowpea, Mohapatra (1998) in rice bean,Ram and Dixit (2001) in green gram, Kumar and Puri (2002) and Singh and Verma (2002) in

French bean, Kumar *et al.*,(2002) in mung bean, Bokade (2008) in yard long bean.

Effect of Interaction

The data pertaining to interaction effect of spacing and nitrogen in various treatment combinations on number of pods per plant are presented in Table 12.The data revealed that the maximum number of days were recorded in S_2N_1 (2239.87) and followed by S_1N_1 (2186.20) which was at par with S_3N_1,S_2N_3, S_3N_3, S_3N_2, S_1N_2, S_2N_2 and S_1N_3.

The trend of effect of various nitrogen levels on number of pods per plant was as follows:

S_2N_1 >S_1N_1 > S_1N_3 > S_2N_2 >S_1N_2> S_3N_2> S_2N_3> S_3N_3> S_3N_1

The results showed that more number of pods were harvested in closer spacing which might be due to availability of more congenial microclimate for the growth. The highest number of pods harvested in N_1 might be due to more availability of nutrient.

Similar findings in relation to effect of spacing and nitrogen interaction on number of pods per plant were also observed by Vakeswaran and Vijayakumar (2005) in pea, Bokade (2008) in yard long bean.

4.3.4**Number of pickings**

The data pertaining to number of pickings of yard long bean as influenced by different spacing, nitrogen levels and their interactionsare presented in Table 13.

Effect of spacing:

Various spacing exhibited significant effecton the number of pickings.The highest number of pickings were recorded in S_1(13.33) which was significantly superior over S_2 (12.22) and S_3 (11.69).

The trend of effect of various nitrogen levels on number of pods per plant was as follows:

$S_1 > S_2 > S_3$

Bokade (2008) in yard long bean found non-significant effect on number of pickings.

Table 13. Effect of spacing, nitrogen and their interactions on number of pickings of yard long bean Var. KonkanWali

No.of picking(Days)				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	14.07	13.53	11.33	**12.98**
N_2	13.40	11.93	12.47	**12.60**
N_3	12.53	11.20	11.27	**11.67**
MEAN	**13.33**	**12.22**	**11.69**	**12.41**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.27	1.09	
N	**SIG**	0.28	0.87	
S X N	**NS**	0.74	-	

Effect of nitrogen

There was significant difference in the number of pickings. The treatment N_1 (60:60:30 kg NPK/ha) and N_2 (90:60:30 kg NPK/ha) recorded maximum number of pickings as compared to N_3 (120:60:30 kg NPK/ha) treatment.

The trend of effect of various nitrogen levels on number of pods per plant was as follows:

$$\underline{N_1 > N_2} > N_3$$

Bokade (2008) in yard long bean found non-significant effect on number of pickings.

Effect of Interaction

In interaction the highest number of pickings were recorded in S_1N_1 (14.07) which was followed by S_2N_1 (13.53), S_1N_2 (13.40) whereas, the lowest number of pickings were recorded in S_2N_3 (11.20). However, the difference among different treatment combinations was non-significant.

The trend of effect of various nitrogen levels on number of pods per plant was as follows:

$$\underline{S_1N_1 > S_2N_1 > S_1N_2 > S_1N_3 > S_3N_2 > S_2N_2 > S_3N_1 > S_3N_3 > S_2N_3}$$

The variation in number of harvestings among various spacing might be due to more planting density which might have created competition for spacing and nutrients in less spacing as compared to wider spacing. In contrast, to nitrogen effect, number of pickings significantly varied due to graded levels of nitrogen.

Similar findings were observed by Bokade (2008) in yard long bean.

4.3.5**Duration of harvest**

The data pertaining to duration of harvest as influenced by various spacing, various nitrogen levels and their interaction are presented in Table 14 and illustrated in Fig. 8

Effect of spacing

The critical perusal of data presented in Table 14 revealed that maximum duration of harvest was recorded in S_1 (54.80) which was significantly superior over S_2 (52.31) and S_3 (52.07).Thus, it indicated that duration for harvest goes on decreasing with increase in the spacing.

The trend of effect of spacing on duration for harvest was as follows:

$S_1 > S_2 > S_3$

Bokade (2008) in yard long bean found non-significant effect on duration for harvest.

Table 14. Effect of spacing, nitrogen and their interactions on duration of harvest of yard long bean Var. KonkanWali

Duration of harvest				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	58.87	50.93	51.47	**53.76**
N_2	53.93	51.87	51.87	**52.56**
N_3	51.60	54.13	52.87	**52.87**
MEAN	**54.80**	**52.31**	**52.07**	**53.06**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.32	1.29	
N	**NS**	0.61	-	
S X N	**SIG**	2.81	8.66	

Effect of nitrogen

Among the various nitrogen levels tried the maximum duration forharvest was reported in N_1 (53.76) which was significantly superior over N_2 (52.56),N_3 (52.87).

The trend of effect of spacing on duration for harvest was as follows:

$N_1 > N_3 > N_2$

Similar findings were observed by Bokade (2008) in yard long bean on duration of harvest.

Interaction Effect

The data pertaining to interaction effect of spacing and nitrogen in various treatment combinations on duration are

presented in Table 14.The data revealed that maximum duration of harvest was recorded in S_1N_1 (58.87) which was at par with all the treatment combinations.

Thus, it is evident that the treatment combination having closer spacing recorded maximum duration for harvest as compared to wider spacing recorded maximum duration for harvest which might be due to favorable micro-climate available in the plots.

The trend of duration for harvest recorded in various treatment combination was as follows:

$S_1N_1 > S_2N_3 > S_1N_2 > S_3N_3 > S_3N_2 = S_2N_2 > S_1N_3 > S_3N_1 > S_2N_1$

Bokade (2008) in yard long beanfound non-significant result on duration for harvest.

4.3.6 **Pod yield per plant (g)**

The data pertaining to the pod yield per plant (kg) as influenced by different spacing, nitrogen levels and their interactions is presented in Table 15 and illustrated in Fig. 9

Effect of spacing

The critical perusal of data presented in table 15 revealed that, the highest pod yield per plant was recorded in S_1(0.63 g) which was significantly superior over the S_2 (0.54 g) and S_3(0.53 g).Thus, the difference among the various spacing tried was significant.

The trend of effect of spacing on pod yield per plant (g) recorded in various treatment was as follows:

$S_1 > S_2 > S_3$

The results obtained are in accordance with the results of Sarvaiya*et al.*, (1993) in pigeon pea, Bokade (2008) in yard long bean, Pande*et al.*, (1974) and Dev (2010) in French bean.

Table 15. Effect of spacing, nitrogen and their interactions on pod yield (g/plant) of yard long bean Var. KonkanWali

Pod yield per plant (g)				
	S1	**S2**	**S3**	**MEAN**
N1	0.68	0.58	0.57	**0.61**
N2	0.54	0.58	0.51	**0.54**
N3	0.68	0.45	0.51	**0.55**
MEAN	**0.63**	**0.54**	**0.53**	**0.56**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.005	0.01	
N	**SIG**	0.015	0.04	
SX N	**SIG**	0.069	0.21	

Effect of Nitrogen

Effect of various nitrogen levels in respect of pod yield per plant was found to be significant. The highest pod yield per plant was recorded in N_1 (0.61 g) which was significantly superior over the N_2 (0.54 g) and N_3 (0.55 g).

The trend of effect of various nitrogen levels on pod yield per plant (kg) in descending order was as follows:

$$\underline{N_1 > N_3} > N_2$$

Similar results was obtained by Bokade (2008) in yard long bean.

Interaction Effect

Among the various treatment combination the highest fruit yield per plant was recorded in S_1N_1(0.68 g) and S_1N_3(0.68 g) and which was at par with $S_1N_1$and significantly superior over rest of treatment combination. The lowest pod yield per plant was recorded in S_2N_3 (0.40 g).

The trend of effect of various treatment combinations on pod yield per (g) in descending order was as follow:

$S_1N_1 = S_1N_3 > S_2N_1 = S_2N_2 > S_3N_1 > S_2N_2 > S_3N_3 = S_3N_3 > S_2N_3$

Above results indicated that more pod yield per plant in closer spacing and in higher nitrogen levels. The closer spacing might have created more congenial microclimate for proper growth and production and resulted in higher yield. Whereas, proper availability of nutrients in N_1 ultimately resulted in more yield per plant.

Similar results were obtained by Bokade (2008) in yard long bean.

4.3.7**Green pod yield per plot (kg)**

The data pertaining to the effect of spacing, nitrogen levels and their interactions on green pod yield per plot is presented in table 16.

Effect of spacing

The critical perusal of data presented in Table 16 revealed the significant difference in the green pod yield per plot (kg) in various spacing. The highest yield per plot was observed in S_1(22.77 kg) which was significantly superior over S_2 (9.66 kg) and S_3(6.37 kg). whereas, the lowest yield per plot was observed in S_3. Thus, Yield per plot was decrease with increase in spacing.

The trend of effect of spacing on yield per plot (kg) in descending order was as follows:

$S_1 > S_2 > S_3$

The higher pod yield per plot was recorded in closer spacing might be due to fruit set percentage, environmental factors and vigour of the crop in S_1which has allowed the plant to grow with its full potential.

These results are in line with the findings of Singh and Behera (1999), Chaudhary (2009) and Pande*et al.*,(1974) in French bean, Valayutham*et al.*, (2000) in red gram, Nagaraju*et al.*, (2001) in

pigeon pea, Parameswari*et al.*, (2003) in pigeon pea and Swain and Rath (2006) and Nersekar (2016) in yambean and Bokade (2008) in yard long bean.

Table 16. Effect of spacing, nitrogen and their interactions on green pod yield (kg/plot) of yard long bean Var. KonkanWali

Green pod yield per plot (kg)				
	S1	**S2**	**S3**	**MEAN**
N1	24.52	10.50	6.84	**13.95**
N2	19.32	10.44	6.16	**11.97**
N3	24.48	8.04	6.12	**12.88**
MEAN	**22.77**	**9.66**	**6.37**	**12.93**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.09	0.36	
N	**SIG**	0.27	0.83	
S X N	**SIG**	2.01	6.21	

Effect of nitrogen

Among the various nitrogen levels tried under present investigation the highest yield per plot was observed in N_1(13.95 kg) which was significantly superior over N_2 (11.97 kg) and N_3 (12.88 kg). The increase in the yield per plot was exhibited with increase in nitrogen levels and the difference among the different nitrogen levels was significant.

The trend of effect of nitrogen of various nitrogen levels on yield per plot (kg) in descending order was as follows:

$$\underline{\mathbf{N_1 > N_3 > N_2}}$$

The highest pod yield per plot was recorded in N_1(13.95 kg) higher nitrogen doses as compared to lower nitrogen doses (N_2 and N_3). This might be due to optimum nutrient available in the N_1 which resulted in increasing the yield per plot in N_1(13.95 kg).

The above results are in accordance with Singh and Behera (1999) and Kumar and Puri (2002) and Kumar *et al.,* (2002) in French bean, Swain and Rath (2006) in yam bean, Ram and Dixit (2001) in green gram and Bokade (2008) in yard long bean.

Effect of Interaction

Data presented in Table 16 regarding on yield (kg/plot) shows the effect of various treatment combinations, which revealed that the significant difference in yield per plot (kg). The highest yield per plot was observed in S_1N_1 (24.52 kg) which is at par with all treatments except the treatment combinations *viz*. S_1N_1 (24.52 kg), S_1N_3 (24.48 kg), S_1N_2 (19.32 kg), S_2N_1 (10.50 kg), S_2N_2 (10.44 kg), S_2N_3 (8.04 kg), S_3N_1 (6.84 kg), S_3N_2 (6.16 kg) and S_3N_3 (6.12 kg) were at par with each other.

The trend of effect of various treatment combinations on yield per plot (kg) in descending order was as follows:

S_1N_1> S_1N_3>S_1N_2> S_2N_1> S_2N_2> S_2N_3> S_3N_1> S_3N_2> S_3N_3

The variation in pod yield per plot with spacing might be due to the fruit set, number of fruits per plant, fruit weight and micro-climate in the plot. Different levels of nitrogen have a significant effect in pod yield per plot (kg). Increased nitrogen availability produced higher pod yield per plant which was also due to higher fruit length, higher fruit weight and higher number of pods per plant, which ultimately increased the pod yield per plot.

The results obtained are in accordance with the findings of Chatterjee and Som (1991) and Koli*et al.*, (1996) in French bean, Sharma (1994) in spinach,Nagaraju*et al.*, (2001) in cowpea, Swain and Rath (2006) in yam bean and Bokade (2008) in yard long bean.

4.3.8**Pod yield per hectare (t)**

The data pertaining to the yield per hectare (t) as influenced by different spacing, nitrogen levels and their interactions are presented in Table 17 and illustrated in Fig. 10

Table 17. Effect of spacing, nitrogen and their interactions on green pod yield (kg/ha) of yard long bean Var. KonkanWali

Pod yield per hectare (t)				
	S1	**S2**	**S3**	**MEAN**
N1	17.66	7.56	4.93	**10.05**
N2	13.91	7.52	4.44	**8.62**
N3	17.63	5.79	4.41	**9.28**
MEAN	**16.40**	**6.96**	**4.59**	**9.31**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.06	0.26	
N	**SIG**	0.19	0.60	
S X N	**SIG**	1.45	4.47	

Effect of spacing

Effect of various spacing tried under study revealed significant difference in pod yield per hectare (t). The highest yield per hectare was recorded in S_1(16.40 t) which was significantly superior over S_2 (6.96 t) and S_3 (4.59 t). The lowest fruit yield per hectare was recorded in S_3 (4.59 t).

The trend of effect of spacing on pod yield per hectare (t) in descending order was as follows:

$$\underline{S_1 > S_2 > S_3}$$

The highest pod yield per hectare was recorded in closer spacing S_1might be due to fruit set percentage, environmental factor and vigor of the crop.

These results are in line with the findings of Singh and Behera (1999), Chaudhary (2009) and Pande*et al.*,(1974) in french bean,

Valayutham*et al.*, (2000) in red gram, Nagaraju*et al.*, (2001) in pigeon pea, Parameswari*et al.*, (2003) in pigeon pea, Swain and Rath (2006) and Nersekar (2016) in yambean and Bokade (2008) in yard long bean.

Effect of Nitrogen

The highest pod yield per hectare was recorded in N_1(10.05 t) which was at par with N_2 (8.62 t) and N_3(9.28 t). The lowest yield per hectare was recorded in N_2 (9.28 t). The difference among the different treatment combinations was significant.

The trend of effect of various nitrogen levels on pod yield per hectare (t) in descending order was as follows:

$$\mathbf{N_1 > N_3 > N_2}$$

The highest pod yield per hectare was produced in higher nitrogen dose (N_3). This might be due to the availability of optimum nutrient in the plot of higher nitrogen dose which resulted in increasing the pod yield per hectare in N_3.

The above results are in accordance with Singh and Behera (1999) and Kumar and Puri (2002) and Kumar *et al.,* (2002) in French bean and Swain and Rath (2006) and Bokade (2008) in yam bean and Ram and Dixit (2001) in green gram.

Interaction Effect

Interaction effect of spacing and nitrogen levels on pod yield per hectare (t) exhibited significant effect among various treatment combinations. The highest pod yield per hectare was observed in S_1N_1 (17.66 t) which was at par with all treatments.

The trend of effect of various treatment combinations on pod yield per hectare (t) in descending order was as follows:

$$\mathbf{S_1N_1 > S_1N_3 > S_1N_2 > S_2N_1 > S_2N_2 > S_2N_3 > S_3N_1 > S_3N_2 > S_3N_3}$$

The pod yield per hectare was higher at closer spacing. This variation might be due to the fruit set, environmental factors and vigour of the crop in S_1 as compared to S_2 and S_3. Different levels of (N)nitrogen have significant effect on pod yield per hectare (t).Increased nitrogen levels produced higher pod yield per plant might be due to highest pod length, higher number of pods per plant, highest pod yield per plot and eventually higher pod yield per hectare.

The results obtained are in accordance with the findings of Chatterjee and Som (1991) and Koli*et al.*, (1996) in french bean, Sharma (1994) in spinach, Nagaraju*et al.*, (2001) in cowpea, Swain and Rath (2006) in yam bean and Bokade (2008) in yard long bean.

4.4 **Effect of spacing, nitrogen and their interactions on qualitative parameters**

4.4.1 **Physical parameter**

Physical parameters *viz.* length and girth of pod, number of seeds per pod and weight of green pods showed notable effects among all treatments of yard long bean. The results obtained of these parameters are presented in following Table.

4.4.1.1 **Length of pod (cm)**

The data pertaining to the length of pod as influenced by different spacings, nitrogenlevels and their interactions are presented in Table 18.

Effect of Spacing

The critical perusal of data presented in table 18 revealed that highest length of pod was recorded in S_3(34.73 cm) which was significantly superior over S_1 (33.08 cm) and S_2(32.24 cm). The lowest length of pod was recorded in S_2(32.24 cm).

The trend of effect of various treatment combinations on length of pod in descending order was as follows:

S_3>S_1>S_2

The results are in conformity with the findings reported by Maya *et al.*, (1997) in bell pepper and Sinha (1975), Chougule and Mahajan (1979) in chilli, Joshi and Rahevar (2015) in Indian bean, Singh and Behera (1999) in French bean, Bokade (2008) in yard long bean.

Table 18. Effect of spacing, nitrogen and their interaction on length of pod (cm) of yard long bean Var. Konkanwali

Length of pod				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	37.66	33.63	32.70	**34.66**
N_2	32.95	30.45	35.03	**32.81**
N_3	28.64	32.63	36.45	**32.57**
MEAN	**33.08**	**32.24**	**34.73**	**33.34**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.33	1.30	
N	**SIG**	0.40	1.25	
S X N	**NS**	3.36	-	

Effect of Nitrogen

The data pertaining to the length of pod (cm) are presented in table 18. It is evident from the data that the different treatment combination significantly influenced the length of pod. The treatment N_1(34.66 cm) recorded highest pod length, while it was lowest in N_3(32.57 cm).Further, it was noticed that the top ranking treatment N_1 was superior over two treatment. N_1had higher value for pod length than that of population mean of 33.34 cm.

The trend of effect of various nitrogen levels on length of pod in descending order was as follows:

$$\mathbf{N_1 > N_2 > N_3}$$

The effect of nitrogen in above character was also observed by Singh and Behera (1999) in French bean, Bokade (2008) in yard long bean.

Effect of interaction

Effect of various treatment combinations tried under study revealed that there was non-significant difference among length of pod influenced by either spacing, nitrogen levels and there interactions. The highest length of pod was observed in S_3N_3 (36.45 cm) which was at par with the rest of treatment combinations whereas, the lowest length of pod was observed in S_1N_3 (28.64 cm).

The trend of effect of various treatment combinations on length of pod in descending order was as follows:

$$\mathbf{S_3N_3 > S_3N_2 > S_1N_1 > S_2N_1 > S_1N_2 > S_3N_1 > S_2N_3 > S_2N_2 > S_1N_3}$$

Thus, it revealed that spacing, nitrogen and their interactions had much effect on length of pod might be due to availability of micro-climate in the plot.

Similar result was obtained by Bokade (2008) in yard long bean.

4.4.1.2 **Girth of Pod (cm)**

The data pertaining to the girth of pod as influenced by different spacings, nitrogen levels and their interactions are presented in Table 19.

Effect of spacing

Spacing exhibited non-significant effect on the girth of pod. The highest girth of pod was recorded in S_3 (2.56 cm) and the lowest girth of pod was recorded in S_2 (2.45 cm).

The trend of effect of spacing on girth of pod (cm) in descending order was as follows:

$S_3 > S_1 > S_2$

Similar results was obtained by Bokade (2008) in yard long bean.

Table 19. Effect of spacing, nitrogen and their interaction on girth of pod (cm) of yard long bean Var. Konkanwali

Girth of pod (cm)				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	2.45	2.53	2.63	**2.53**
N_2	2.45	2.35	2.59	**2.46**
N_3	2.50	2.47	2.51	**2.49**
MEAN	**2.46**	**2.45**	**2.56**	**2.49**
	RESULT	**SEM±**	**CD@5%**	
S	**NS**	0.03	-	
N	**NS**	0.03	-	
S X N	**NS**	0.06	-	

Effect of nitrogen

The various nitrogen levels tried under study showed non-significant differences on the girth of pod. The highest girth of pod was recorded inN_1 (2.53 cm) and the lowest girth of the pod was recorded in N_2(2.46 cm).

The trend of effect of various nitrogen levels on girth of pod (cm) in descending order was as follows:

$N_1 > N_3 > N_2$

However, the significant result was observed by Singh and Behera (1999) in French bean, and similar result was found by Bokade (2008) in yard long bean.

Effect of Interaction

In interaction, the highest girth of pod was recorded in S_3N_1 (2.63 cm) whereas, the lowest girth of pod was recorded in S_2N_2

(2.35 cm).The difference among different treatment combination was non-significant.

The trend of effect of various treatment combinations on girth of pod (cm) in descending order was as follows:

S_3N_1>S_3N_2>S_2N_1>S_3N_3>S_1N_3>S_2N_3>S_1N_1=S_1N_2>S_2N_2

Similar findings was recorded by Bokade (2008) in yard long bean.

4.4.1.3 **Number of seeds per pods**

The data pertaining to the number of seeds per pod as influenced by different spacing, nitrogen levels and their interactions is presented in Table 20.

Table 20. Effect of spacing, nitrogen and their interactions on number of seeds per pod of yard long bean Var. KonkanWali

No. of seeds per pod				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	16.27	14.27	15.13	**15.22**
N_2	14.67	12.93	14.53	**14.04**
N_3	12.27	14.80	17.87	**14.98**
MEAN	**14.40**	**14.00**	**15.84**	**14.74**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.35	1.37	
N	**NS**	0.40	-	
S X N	**NS**	1.86	-	

Effect of spacing

The critical perusal of data presented in table 20 revealed that maximum number of seeds per pod were produced in S_3 (15.84) which was significantly superior over S_2 (14.00). The minimum number of seeds per pod were recorded in S_2.

The trend of effect of various spacings on number of seeds per pod in descending order was as follows:

$$\underline{S_3 > S_1} > S_2$$

The highestnumber of seeds per pod were in wider spacing which might be due to availability of sufficient space for the plants in plot.

The results obtained are in accordance with the findings of Chatterjee and Som (1991) and Pawar*et al.*, (2006) in french bean, Joshi and Rahevar (2015) in Indian bean, Bokade (2008) in yard long bean andMohapatra (1998) in rice bean.

Effect of Nitrogen

The critical perusal of data presented in table 20 revealed non-significant differences among the various nitrogen levels. The maximum number of seeds per pod were recorded in N_1 (15.22) and the minimum number of seeds per pod were recorded in N_2 (14.04).

The trend of effect of various spacing on number of seeds per pod in descending order was as follows:

$$N_1 > N_3 > N_2$$

The effect of nitrogen in the above character was observed by Puste and Jana (1980) in pigeon pea, Kumar *et al.*, (2002) in mung bean, Singh and Verma (2002) in French bean andBokade (2008) in yard long bean.

Effect of Interaction

Perusal of table 20 indicated that the interaction of spacing and nitrogen was found to be non-significant with highest number of seeds per pod (17.87) by the interaction of S_3N_3.Significantly minimum number of seeds per pod (12.27) were recorded by the S_1N_3. Further, it was found that the top ranking interaction $S_3N_3$was at par with all other treatments.

The trend of effect of various treatment combinations on number of seeds per pod in descending order was as follows:

S_3N_3>S_1N_1>S_3N_1>S_2N_3>S_1N_2>S_3N_2>S_2N_1>S_2N_2>S_1N_3

Similar result was reported by Vakeswaran and Vijayakumar (2005) in Pea and Bokade (2008) in yard long bean.

4.4.1.4 **Weight of green pod (g)**

The data pertaining to the weight of green pod as influenced by different spacing, nitrogen levels and their interactions is presented in Table 21.

Effect of Spacing

The critical perusal of data presented in table 21 revealed that highest weight of green pod was produced in S_1 (12.64 g) which was significantly superior over S_3 (10.11 g). Thus, it indicated that weight of green pod went on decreasing with increase in the spacing.

The trend of weight of green pod per plant in various spacings was as follows:

S_1>S_2>S_3

Similar findings in relation to weight of green pod (g) were also observed by Satodiya*et al.*, (2010) in cowpea, Singh and Behera (1999) and Pawar*et al.*, (2007) in French bean.

Table 21. Effect of spacing, nitrogen and their interactions on weight of green pod of yard long bean Var. KonkanWali

Weight of green pod (g)				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	13.80	11.13	10.27	**11.73**
N_2	12.47	10.67	9.47	**10.87**
N_3	11.67	12.20	10.60	**11.49**
MEAN	**12.64**	**11.33**	**10.11**	**11.36**

	RESULT	SEM±	CD@5%
S	**SIG**	0.41	1.61
N	**NS**	0.47	-
S X N	**NS**	0.87	-

Effect of Nitrogen

It is evident from the data that various nitrogen levels showed non-significant effect on weight of green pod. The highest pod weight (11.73 g) was recorded in N_1, whereas lowest weight of pod (10.87 g) was recorded in N_2.

The trend of effect of various nitrogen levels on weight of pod (g) in descending order was as follows:

$$\mathbf{N_1 > N_3 > N_2}$$

Effect of Interaction

The various treatment combinations tried under study recorded non-significant difference in respect of weight of green pod. The highest weight of pod was observed in S_1N_1 (13.80 g) and lowest weight of green pod was observed in S_3N_2 (9.47 g).

The trend of effect of various nitrogen levels on weight of pod (g) in descending order was as follows:

$$\mathbf{S_1N_1 > S_1N_2 > S_2N_3 > S_1N_3 > S_2N_1 > S_2N_2 > S_3N_3 > S_3N_1 > S_3N_2}$$

4.4.1.5 **Weight of flesh per pod (g)**

The data pertaining to the girth of pod as influenced by different spacing, nitrogen levels and their interactions is presented in Table 22.

Table 22. Effect of spacing, nitrogen and their interactions on weight of flesh per pod of yard long bean Var. KonkanWali

Weight of flesh per pod (g)

	S_1	S_2	S_3	MEAN
N_1	8.00	6.80	5.67	**6.82**
N_2	10.27	6.53	7.20	**8.00**
N_3	5.80	7.00	7.40	**6.73**
MEAN	**8.02**	**6.78**	**6.76**	**7.18**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.15	0.60	
N	**SIG**	0.09	0.27	
S X N	**SIG**	1.49	4.59	

Effect of Spacing

The spacing levels showed a significant effect on weight of flesh per pod. The data ranged from 6.76 g to 8.02 g with mean 7.18 g. The closer spacing S_1 recorded significantly the highest weight of flesh per pod (8.02 g) and was found superior over S_2 and S_3.The treatment S_1 recorded higher weight as compare to mean.

The trend of effect of various spacings on weight of flesh per pod descending order was as follows:

$S_1 > S_2 > S_3$

Effect of nitrogen

The nitrogen levels also showed a significant effect on weight of flesh per pod and significantly highest weight of flesh (8.00 g) was recorded byN_2 treatment and which was superior over N_1 and N_3. The lowest weight of flesh (6.73 g) was observed in N_3 treatment.

The trend of effect of various nitrogen levels on weight of flesh per pod in descending order was as follows

$N_2 > N_1 > N_3$

Effect of interaction

The interaction effect between spacings and nitrogen on weight of flesh per pod was found to be significant. Significantly highest

weight of flesh per pod (10.27 g) was recorded in the interaction S_1N_2 and was at par with each other.

The trend of effect of various treatment combination on weight of flesh per pod in descending order was as follows:

S_1N_2>S_1N_1>S_3N_3>S_3N_2>S_2N_3>S_2N_1>S_2N_2>S_1N_3>S_3N_1

4.4.1.6 **Weight of grains per pod (g)**

The data pertaining to the weight of grainsper pod as influenced by different spacings, nitrogen levels and their interactions are presented in Table 23.

Table 23. Effect of spacing, nitrogen and their interactions on weight of grains per pod of yard long bean Var. KonkanWali

Weight of grains per pod (g)				
	S_1	**S_2**	**S_3**	**MEAN**
N_1	2.60	3.40	2.20	**2.73**
N_2	5.53	2.53	4.27	**4.11**
N_3	2.60	3.40	2.40	**2.80**
MEAN	**3.58**	**3.11**	**2.96**	**3.21**
	RESULT	**SEM±**	**CD@5%**	
S	**SIG**	0.05	0.21	
N	**SIG**	0.07	0.23	
S X N	**NS**	1.14	-	

Effect of spacing

The spacing levels showed a significant effect on weight of grains per pod. The data ranged from 2.96 g to 3.58 g with mean 3.21 g. The closer spacing S_1 recorded significantly the highest weight of grains per pod (3.58 g) and was found superior over S_2 and S_3.The treatment S_1 recorded higher weight of grains per pod as compare to mean.

The trend of effect of various spacings on weight of grains per pod in descending order was as follows:

$S_1>S_2>S_3$

Effect of nitrogen

The nitrogen levels also showed a significant effect on weight of grains per pod and significantly highest weight of grains (4.11 g) was recorded byN_2 treatment which was superior over N_1 and N_3. However the N_1 and N_3 were at par with each other. The lowest weight of grains (2.73 g) was observed in N_1 treatment.

The trend of effect of various nitrogen levels on weight of grains per pod in descending order was as follows

$N_2>N_1>N_3$

Effect of interaction

The interaction effect between spacing and nitrogen on weight of grains per pod was found to be non-significant. Highest weight of grains per pod (5.53 g) was recorded in the interaction S_1N_2which was at par with othertreatments.

The trend of effect of various treatment combination on weight of grains per pod descending order was as follows:

$S_1N_2>S_3N_2>S_2N_1=S_2N_3>S_1N_1=S_1N_3>S_3N_3>S_3N_1>S_2N_2$

4.4.1.7 **Color of pod and Seed**

The observations regarding color of pod and color of seed are presented in Table 24 showed pod and seed color. The seed color was brown. The pod color was light green.

The color of the pod is an important quality parameter, though it does not affect yield, it decides the consumer preference and there by marketability, which may vary in various markets. The color of seed is also an important character.

Table 24. Effect of spacing, Nitrogen and their interaction on color of pod and seed of yard long bean Var. KonkanWali.

Sr. No.	Treatment	Pod color	Seed color
1	T_1	Light green	Brown
2	T_2	Light green	Brown
3	T_3	Light green	Brown
4	T_4	Light green	Brown
5	T_5	Light green	Brown
6	T_6	Light green	Brown
7	T_7	Light green	Brown
8	T_8	Light green	Brown
9	T_9	Light green	Brown

CHAPTER V

SUMMARY AND CONCLUSION

The present investigation entitled "Effect of spacing and fertilizer on growth, yield and quality of yard long bean (*Vignaunguiculata*sub sp. *Sesquipedalis*) var. 'KonkanWali' grown under Konkan agro-climatic conditions of Maharashtra" was conducted with the following objectives:

1) To study the effect of different spacing's on growth and yield of yard long bean.
2) To study the effect of different fertilizers o growth and yield of yard long bean.

The present experiment was conducted in Split Plot Design consisting of three spacing's *viz*. S_1 (90×30 cm), S_2 (90×60 cm), S_1 (90×90 cm) and nitrogen levels *viz*. N_1(60:60:30 kg NPK/ha), N_2(90:60:30 kg NPK/ha), N_3(120:60:30 kg NPK/ha) and were replicated thrice.

The data obtained during present investigation was statistically analyzed as per the methods prescribed by Panse and Sukhatme (1995).The important findings of present investigation are summarized below:

5.1**Growth Parameters.**

5.1.1 **Effect of spacing on the vegetative growth parameters of yard log bean.**

All the growth observations *viz.* number of primary branches, length of vine, number of nodes and internodal length varied significantly among various spacings under study.

At 60 DAS, the highest length of vine was observed in S_3 (278.02 cm) whereas, the lowest was observed in S_2 (254.53 cm) with mean of 265.16 cm.

Similarly, At 60 DAS, the highest number of primary branches were recorded in S2 (17.82) and the lowest in S3 (12.82) with mean of 15.38.At 120 DAS, the highest number of primary branches were recorded in S_3 (46.67) and the lowest in S_1 (43.76) with mean of 45.45 and was found significant.

Number of nodes At 60 DAS, were found significant and highest number of nodes were recorded in S_2 (75.58) and the lowest in S_3 (68.13) with mean of 71.06.Similarly, At 120 DAS, number of nodes were also found significant and the highest number of nodes were recorded in S_2 (283.7) and the lowest in S_1 (237.38) with mean of 259.18.

The highest internodal length was observed in S_2 (14.80 cm) whereas, the lowest in S_1 (11.32 cm) with mean of 13.28 at 60 DAS. At 120 DAS, the highest internodal length was observed in S_1 (22.42 cm) whereas, the lowest in S_2 (19.81 cm) with mean of 20.28.

The number of leaves at 60 DAS, were observed highest in S_1 (91.41) and lowest in S_3 (68.80) with mean of 80.33.Similarly, At 120 DAS, highest number of leaves were observed in S_2 (297.31) and lowest in S_1 (264.33) with mean of 294.50.

The average leaf area was found non-significant at 60 DAS, the highest average leaf area was recorded in S_2 (123.9 cm^2) and the lowest in S_1 (104.88 cm^2) with mean of 117.09. At 120 DAS, highest average leaf area was recorded in S_3 (130.69 cm^2) and the lowest in S_1 (126.72 cm^2) and the difference was found non-significant.

The data regarding total leaf area were found significant. At 60 DAS, the highest total leaf area (cm^2) was observed in S_2 (10081.1 cm^2) and the lowest in S_1 (6562.9 cm^2) with mean of 8456.03 cm^2. At 120 DAS, result was found significant and the highest Total leaf area (cm^2) was observed in S_2 (23597.09 cm^2) and the lowest in S_3 (18808.53 cm^2) with mean of 20791.12 cm^2.

5.1.2 **Effect of nitrogen on the vegetative growth parameters ofyard long bean**

All the growth observations *viz.* number of primary branches, number of nodes, average leaf area, total leaf area and internodal length varied significantly among various fertilizer level under study.

Among the various nitrogen levels tried under present investigation; at 60 DAS, length of vine was found non-significant. The highest length of vine was recorded in N_1 (271.29 cm) whereas, the lowest was observed in N_2 (256.22 cm) with mean of 265.16 cm.

At 60 DAS, the highest number of primary branches were recorded in N_2 (16.56) and the lowest in N_3 (14.09) with mean of 15.38. Result was found significant. At 120 DAS, the highest number of primary branches were recorded in N_3 (50.98) and the lowest in N_1 (40.51) with mean of 45.45.

Similarly, number of nodes At 60 DAS, were found significant and highest number of nodes were recorded in N_2 (84.13) and the lowest in N_3 (54.51) with mean of 71.06.Similarly, At 120 DAS, number of nodes were also found significant and the highest number of nodes were recorded in N_3 (275.96) and the lowest in N_2 (232.24) with mean of 259.18.

The internodal length was found significant. At 60 DAS, highest internodal length was recorded in N_2 (14.15 cm) whereas, the lowest in N_1 (12.62 cm) with mean of 13.28 cm.At 120 DAS, the highest internodal length was observed in N_1 (22.22 cm) whereas, the lowest in N_2 (19.70 cm) with mean of 20.28.

The number of leaves per plant were found significant. At 60 DAS, highest number of leaves were observed in N_2 (98.01) and lowest in N_3 (55.60) with mean of 80.33.Similarly, at 120 DAS, highest number of leaves were observed in N_2 (306.71) and lowest in N_3 (278.26) with mean of 294.50.

The average leaf area was found non-significant. At 60 DAS, the highest average leaf area was recorded in N_3 (124.34 cm^2) and the lowest in N_1 (112.81cm^2) with mean of 117.09cm^2. At 120 DAS, highest average leaf area was recorded in N_3 (132.84 cm^2) and the lowest in N_1 (123.82cm^2) with mean of 128.05cm^2.

At 60 DAS, total leaf area was found non-significant, the highest total leaf area (cm^2) was observed in N_2 (8721.71 cm^2) and the lowest in N_3 (8105.08 cm^2) with mean of 8456.03 cm^2. At 120 DAS, results was found significant and the highest total leaf area (cm^2) was observed in N_3 (225312.70 cm^2) and the lowest in N_1 (13765.46 cm^2) with mean of 20791.12 cm^2.

5.1.3 **Effect of interaction on the vegetative growth parameters of yard long bean**

Among the various interactions tried under present investigation at 60 DAS, The highest length of vine was recorded in S_3N_1 (287.33 cm) whereas, the lowest was observed in S_1N_2 (236.40 cm) with mean of 265.16 cm.

At 60 DAS, the number of primary branches were found significant.The highest number of primary branches were recorded in S_2N_2 (20.53) and the lowest in S_3N_2 (11.33) with mean of 15.38. At 120 DAS, the highest number of primary branches were recorded in S_3N_3 (58.60) and the lowest in S_2N_1 (37.27) with mean of 45.45.

Similarly, number of nodes at 60 DAS, were found significant and highest number of nodes were recorded in S_2N_2 (94.67) and the lowest in S_2N_3 (49.40) with mean of 71.06.Similarly, at 120 DAS, number of nodes were also found significant and the highest number of nodes were recorded in S_3N_3 (316.40) and the lowest in S_3N_2 (184.40) with mean of 259.18.

The internodal length was found significant. At 60 DAS, highest internodal length was recorded in S_2N_2 (17.71 cm) whereas,

the lowest in S_1N_2 (10.73 cm) with mean of 13.28.At 120 DAS, the highest internodal length was observed in S_1N_1 (24.38 cm) whereas, the lowest in S_2N_2 (17.01 cm) with mean of 20.28.

The number of leaves per plant were found significant. At 60 DAS, highest number of leaves were observed in S_2N_2 (109.80) and lowest in S_3N_3 (47.27) with mean of 80.33.Similarly, at 120 DAS, highest number of leaves were observed in S_2N_2 (377.67) and lowest in S_2N_3 (199.87) with mean of 294.50.

The average leaf area was found non-significant. At 60 DAS, the highest average leaf area was recorded in S_3N_3 (135.20 cm^2) and the lowest in S_1N_2 (89.03 cm^2) with mean of 117.09cm^2. At 120 DAS, highest average leaf area was recorded in S_3N_2 (147.35 cm^2) and the lowest in S_1N_2 (110.77 cm^2) with mean of 128.05cm^2.

The total leaf area result was found significant. At 60 DAS, was found significant, the highest total leaf area (cm^2) was observed in S_2N_2 (11244.58 cm^2) and the lowest in S_1N_1 (5818.81 cm^2) with mean of 8456.03 cm^2. At 120 DAS, result was found significant and the highest total leaf area (cm^2) was observed in S_2N_2 (26832.73 cm^2) and the lowest in S_3N_1 (9917.99 cm^2) with mean of 20791.12 cm^2.

5.2**Flowering Behavior**

5.2.1**Effect of spacing on flowering behaviors of yardlong bean**

Flower observations like number of days to first flowering and number of days fifty percent flowering were recorded. The study revealed that the lowest number of days for initiation of first flower was noticed in S_3 (70.27 days) and highest in S_2 (71.91 days) with mean of 71.03 days. Result was found significant.

Similarly, the highest number of days fifty percent flowering was recorded in S_3 (76.58 days) and the lowest number of days in S_2 (76.16 days) with mean of 76.32 days.

5.2.2 **Effect of nitrogen levels on flowering behaviors of yard long bean**.

Among the various fertilizer levels, the N_3 (71.22 days) recorded highest number of days to first flowering and lowest number of days for initiation of first flower was noticed in N_1 (71.20 days) with mean of 71.03

Similarly, the highest number of days fifty percent flowering was recorded in N_3 (76.32 days) and the lowest number of days in N_1 (76.11 days) with mean of 76.32.

5.2.3 **Effect of interaction levels on flowering behavior of yard long bean**.

Among various treatment combinations significant difference for days to first flowering was recorded by S_3N_1 (69.73 days) and lowest number of days for initiation of first flower was noticed in S_2N_1 (73.20 days) with mean of 71.03.

Similarly, the highest number of days fifty percent flowering was recorded in S_1N_3 (73.40 days) and the lowest days in S_3N_3 (79.33 days) with mean of 76.32.

5.3 **Yield and yield attributing character**

The variation in various yield and yield attributing characters under study viz., days to first picking, number of pods/plant, fruit yield per plant (kg), yield per plot (kg), yield her hectare (t) was significant among all the spacings tried.

5.3.1 **Effect of spacing on yield and yield attributing character of yard long bean**

The lowest number of days required for first picking were recorded in S_1 (85.42 days) whereas, the highest in S_2 (87.31 days) with mean of 86.09. Result was found significant.

The lowest number of days from first flowering to harvesting were recorded in S_1 (12.24 days) and highest in S_2 (12.76 days) with mean of 12.55. Result was non-significant.

The highest number of pods per plot was recorded in S_1 (1955.56) and lowest in S_3 (1489.58) with a mean of 1768.80. Result was found significant.

The number of pickings were found significant. The highest number of pickings were recorded in S_1 (13.33) and lowest in S_3 (11.69) with mean of 12.41.

The duration for harvest was found significant. The highest duration was recorded in S_1 (54.80) and lowest in S_3 (52.07) with mean of 53.06.

The pod yield per plant was found significant. The highest yield was recorded in S_1 (0.63 g) and lowest in S_3(0.53 g/plant) with mean of 0.56 g/plant.

The pod yield per plot was found significant. The highest yield was recorded in S_3 (22.77 kg/plot) and lowest in S_3(6.37 kg/plot) with mean of 12.93 kg/plot.

The pod yield per hectare was found significant. The highest yield was recorded in S_1 (16.40t/ha) and lowest in S_3(4.59 t/ha) with mean of 9.31 t/ha.

5.3.2 **Effect ofnitrogen on yield and yield attributing characters of yard long bean**

All the yield and yield attributing characters of yard long bean varied significantly except duration for harvest.

The lowest number of days required for first picking were recorded in N_2 (84.58 days) whereas, the highest in N_3 (88.31 days) with mean of 86.09. Result was found significant.

The lowest number of days from first flowering to harvesting was recorded in N_3 (11.17 days) and highest in N_2 (13.33 days) with mean of 12.55 days. Result was found significant.

The highest number of pods per plot were recorded in N_1 (1931.91) and lowest in N_3 (1639.11) with a mean of 1768.80. Result was found significant.

The number of pickings were found significant. The more number of pickings were recorded in N_1 (12.98) and less in N_3 (11.67) with mean of 12.41.

The duration for harvest was found non-significant. The highest duration was recorded in N_1 (53.76 days) and lowest in N_2 (52.56 days) with mean of 53.06 days.

The pod yield per plant was found significant. The highest yield was recorded in N_1 (0.62 g/plant) and lowest in N_2(0.54 g/plant) with mean of 0.56 g/plant.

The pod yield per plot was found significant. The highest yield was recorded in N_1 (13.95 kg/plot) and lowest in N_2 (11.97 kg/plot) with mean of 12.93 kg/plot.

The pod yield per hectare was found significant. The highest yield was recorded in N_1 (10.05 t/ha) and lowest in N_2 (8.62 t/ha) with mean of 9.31 t/ha.

5.3.3 **Effect of interaction on yield and yield attributing characters of yard long bean**

The lowest days required for first picking were recorded in S_1N_2 (84.58 days) whereas, the highest in S_2N_2 (83.07 days) with mean of 86.09. Result was found significant.

The lowest value for number of days from flowering to harvesting was recorded in S_2N_3 (10.20 days) and highest in S_2N_2 (14.33 days) with mean of 12.55. Result was found significant.

The highest number of pods per plot were recorded in S_2N_1 (2239.87) and lowest in S_3N_1 (1393.67) with a mean of 1768.80. Result was found significant.

The number of pickings were found non-significant. The more number of pickings were recorded in S_1N_1 (14.07) and less in S_3N_1 (11.33) with mean of 12.41.

The duration for harvest was found significant. The highest duration was recorded in S_1N_1 (58.87) and lowest in S_2N_1 (50.93) with mean of 53.06.

The pod yield per plant was found significant. The highest yield was recorded in S_1N_1 (0.68 g/plant), S_1N_3 (0.68 g/plant) and lowest in S_2N_3 (0.45 g/plant) with mean of 0.56 g/plant.

The pod yield per plot was found significant. The highest yield was recorded in S_1N_1 (24.52 kg/plot) and lowest in S_3N_3(6.12 kg/plot) with mean of 12.93 kg/plot.

The pod yield per hectare was found significant. The highest yield was recorded in S_1N_1 (17.66 t/ha) and lowest in S_3N_3(4.41 t/ha) with mean of 9.31 t/ha.

5.4**Physical parameters**

5.4.1**Effect of spacing on physical parameters.**

The length of pod was found significant. The highest length of pod was recorded in S_3 (34.73 cm) and lowest in S_2 (32.24 cm) with mean of 33.34.

The girth of pod found non-significant. The highest girth of pod was recorded in S_3 (2.56 cm) and lowest in S_2 (2.45 cm) with mean of 2.49.

Number of seeds per pod was found significant. The highest seeds per pod were recorded in S_3 (15.84) and lowest in S_2 (14.00) with mean of 14.74.

The weight of green pod was found significant. The highest weight of green pod was recorded in S_1 (12.64 g) and lowest in S_3 (10.11 g) with mean of 11.36.

The weight of flesh per pod was found significant. The highest weight of flesh was recorded in S_1 (8.02 g) and lowest in S_3 (6.76 g) with mean of 7.18.

The weight of grains per pod was found significant. The highest weight of grains per pod was recorded in S_1 (3.58 g) and lowest in S_3 (2.96 g) with mean of 3.21.

5.4.2 **Effect of nitrogen on physical parameters.**

The length of pod was found significant. The highest length of pod was recorded in N_1 (34.66 cm) and lowest in N_3 (32.57 cm) with mean of 33.34.

The girth of pod was found non-significant. The highest girth of pod was recorded in N_1 (2.53 cm) and lowest in N_2 (2.46 cm) with mean of 2.49.

Number of seeds per pod was found non-significant. The highest number of seeds per pod was recorded in N_1 (15.22) and lowest in N_2 (14.04) with mean of 14.74.

The weight of green pod was found non-significant. The highest weight of green pod was recorded in N_1 (11.73 g) and lowest in N_2 (10.87 g) with mean of 11.36.

The weight of flesh per pod was found significant. The highest weight of flesh was recorded in N_2 (8.00 g) and lowest in N_3 (6.73 g) with mean of 7.18.

The weight of grains per pod was found significant. The highest weight of grains per pod was recorded in N_2 (4.11 g) and lowest in N_1 (2.73 g) with mean of 3.21.

5.4.3 **Effect of interaction on physical parameters.**

The length of pod was found significant. The highest length of pod was recorded in S_1N_1 (37.66 cm) and lowest in S_1N_3 (28.64 cm) with mean of 33.34.

The girth of pod was found non-significant. The highest girth of pod was recorded in S_3N_1 (2.63 cm) and lowest in S_2N_2 (2.35 cm) with mean of 2.49.

Number of seeds per pod was found significant. The highest seeds per pod were recorded in S_3N_3 (17.87) and lowest in S_1N_2 (12.27) with mean of 14.74.

The weight of green pod was found non-significant. The highest weight of green pod was recorded in S_1N_1 (13.80 g) and lowest in S_3N_2 (9.47 g) with mean of 11.36.

The weight of flesh per pod was found significant. The highest weight of flesh was recorded in S_1N_2 (10.27 g) and lowest in S_3N_1 (6.73 g) with mean of 7.18.

The weight of grains per pod was found significant. The highest weight of grains per pod was recorded in S_1N_2 (5.53 g) and lowest in S_3N_1 (2.20 g) with mean of 3.21.

CONCLUSION

The present investigation entitled "Effect of spacing and fertilizer on growth and yield of yard long bean (*Vignaunguiculata*sub sp. *Sesquipedalis*) var. 'KonkanWali' it was concluded for better vegetative growth and yield and yield attributing characters along with physical parameters. Yard long bean should be planted at spacing of 90 × 30 cm with application of fertilizer dose 60:60:30 kg NPK/ha.However, same investigation needs to be continued for 2 more seasons for confirmation of present result.

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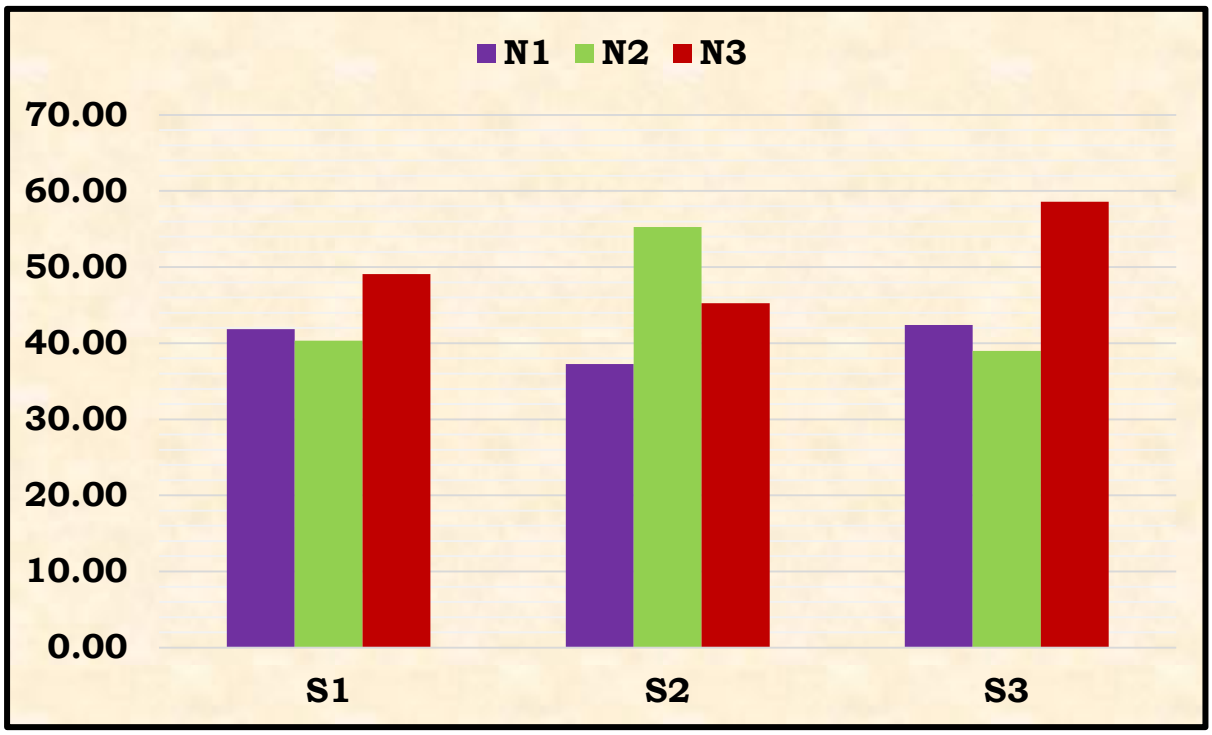


Fig. 2: Effect of spacing, nitrogen and their interactions on number of primary branches at 120 DAS of yard long bean

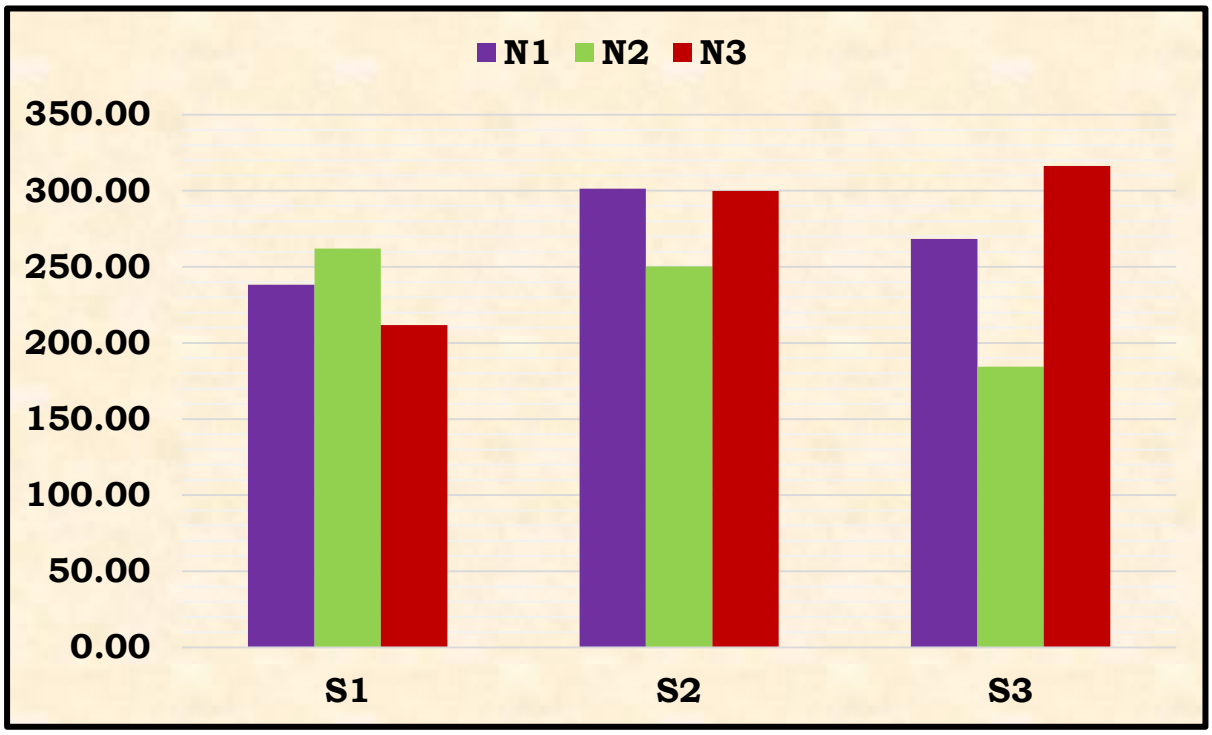


Fig 3: Effect of spacing, nitrogen and their interactions on number of nodes of yard long bean

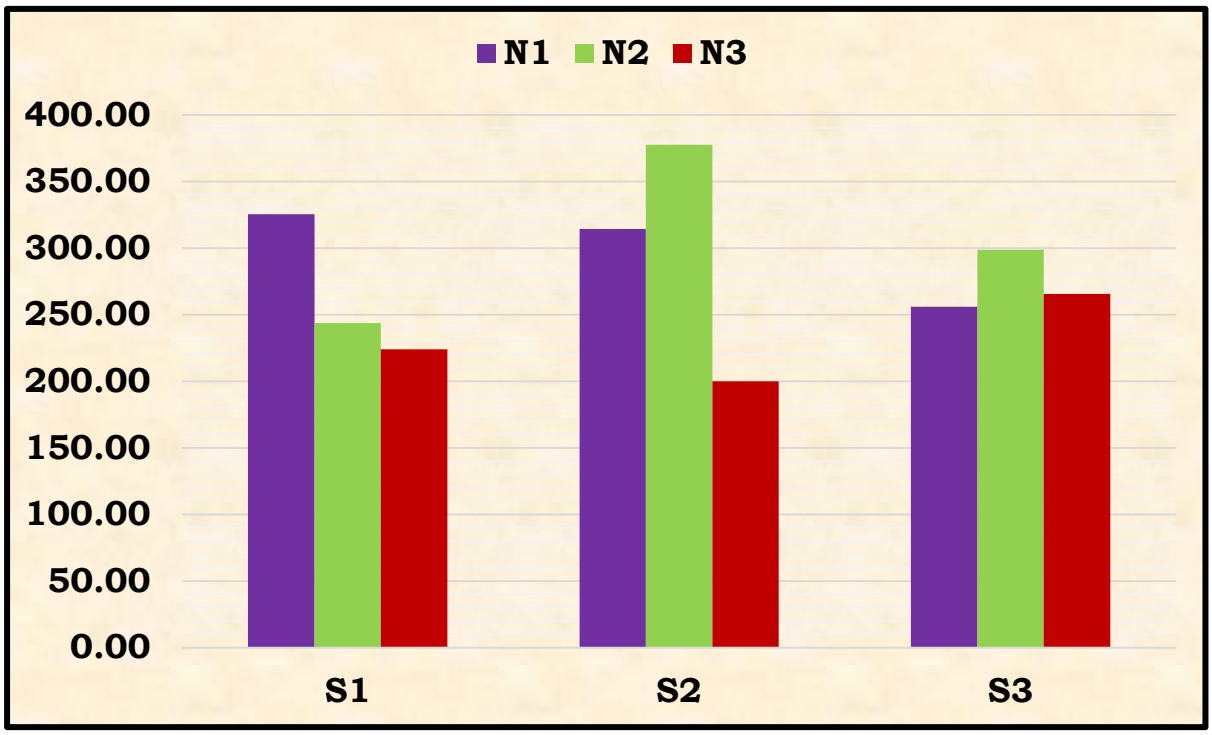


Fig. 4: Effect of spacing, nitrogen and their interactions on number of leaves of yard long bean

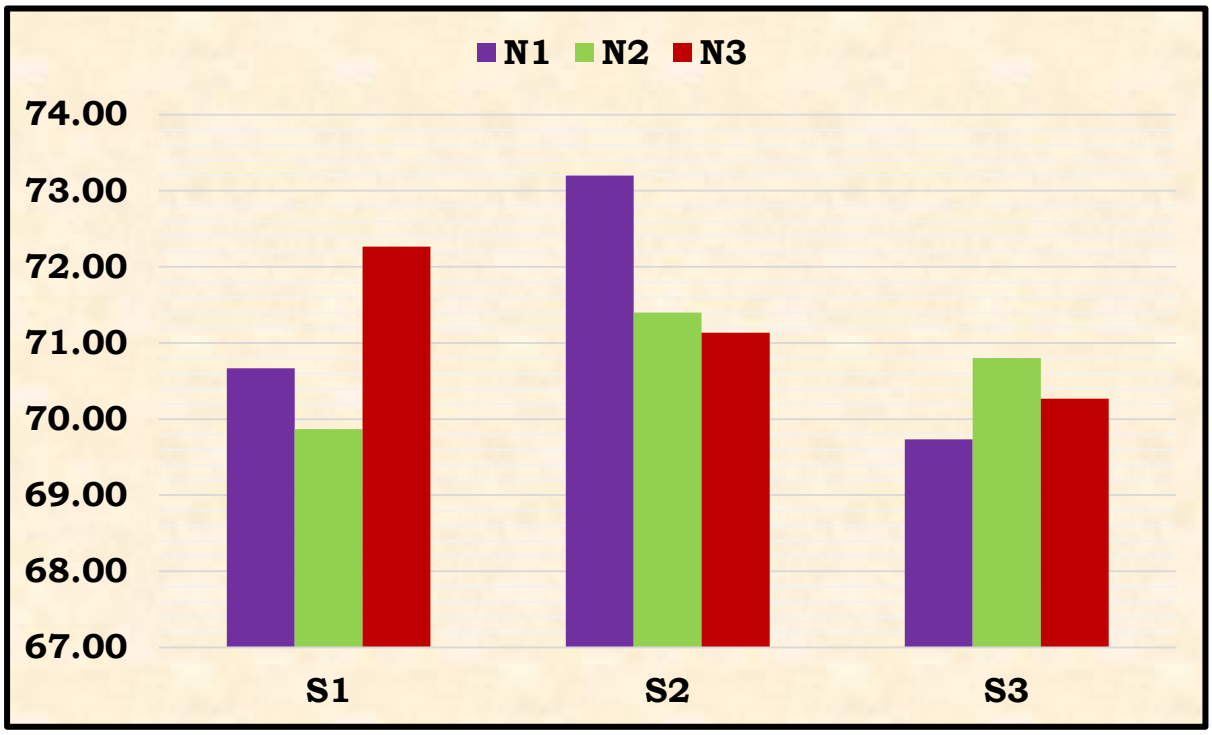


Fig. 5: Effect of spacing, nitrogen and their interactions on days to first flowering of yard long bean

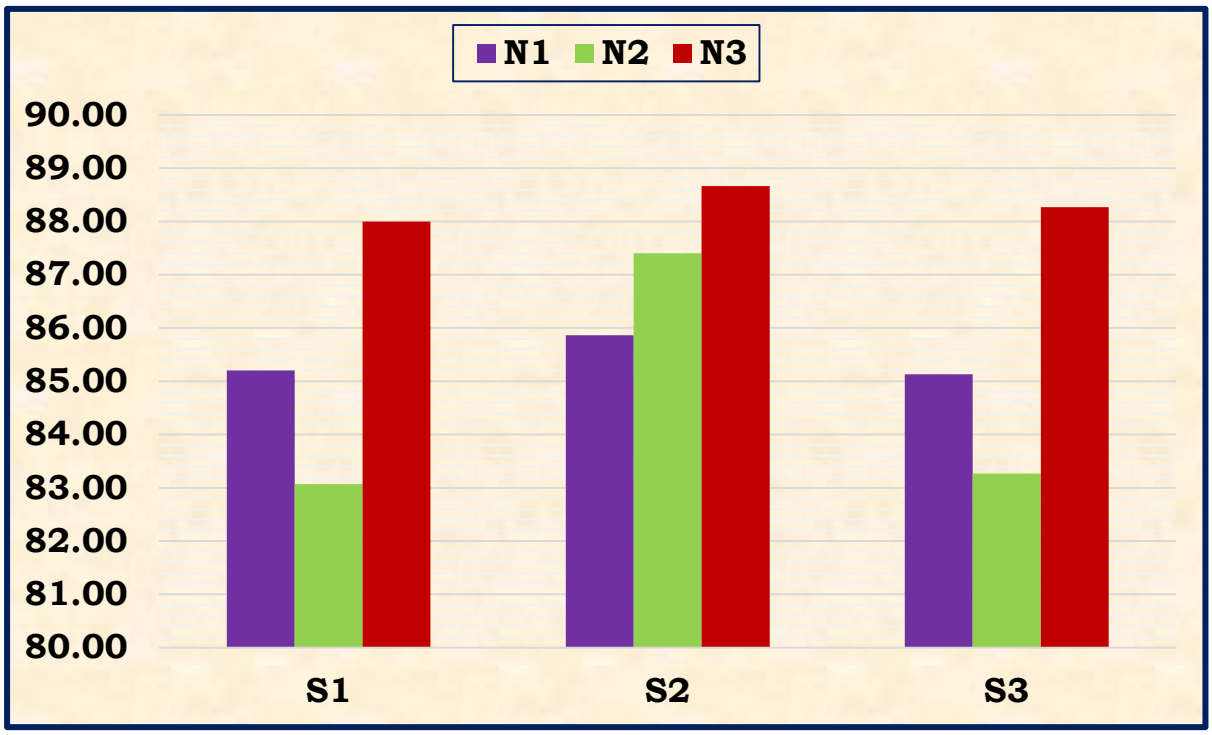


Fig. 6: Effect of spacing, nitrogen and their interactions on days to first picking of yard long bean

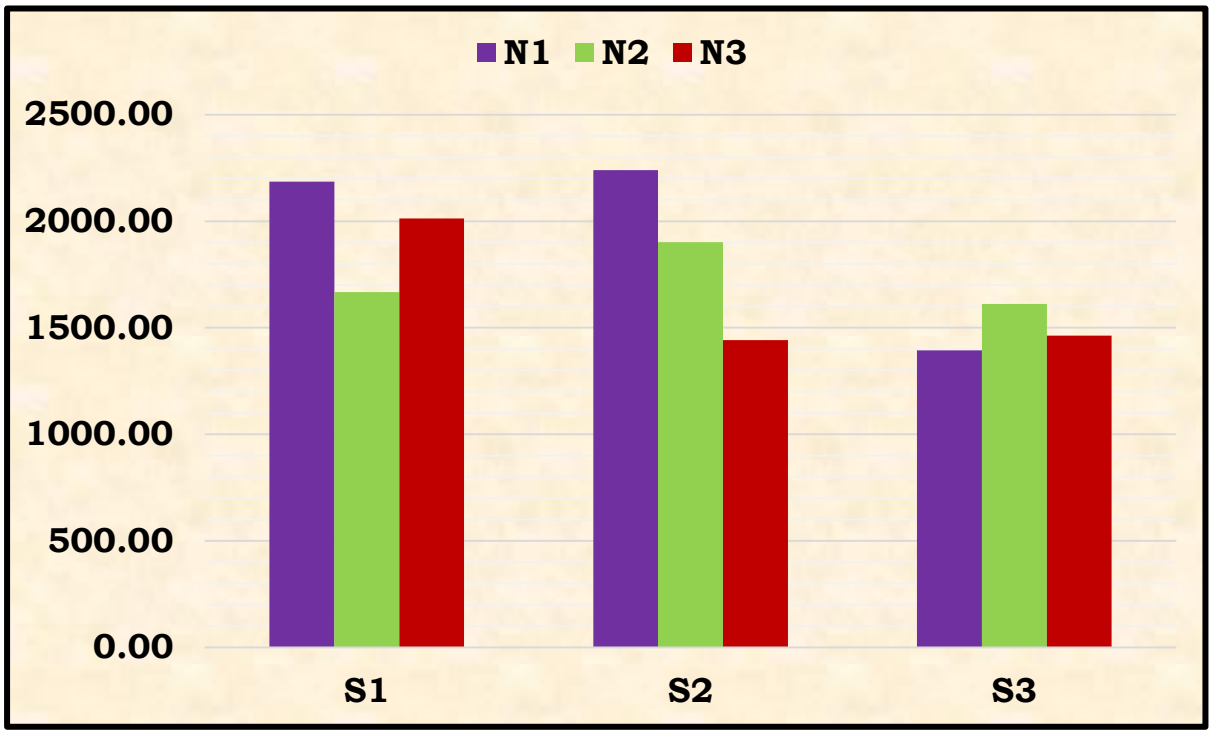


Fig. 7: Effect of spacing, nitrogen and their interactions on number of pods of yard long bean

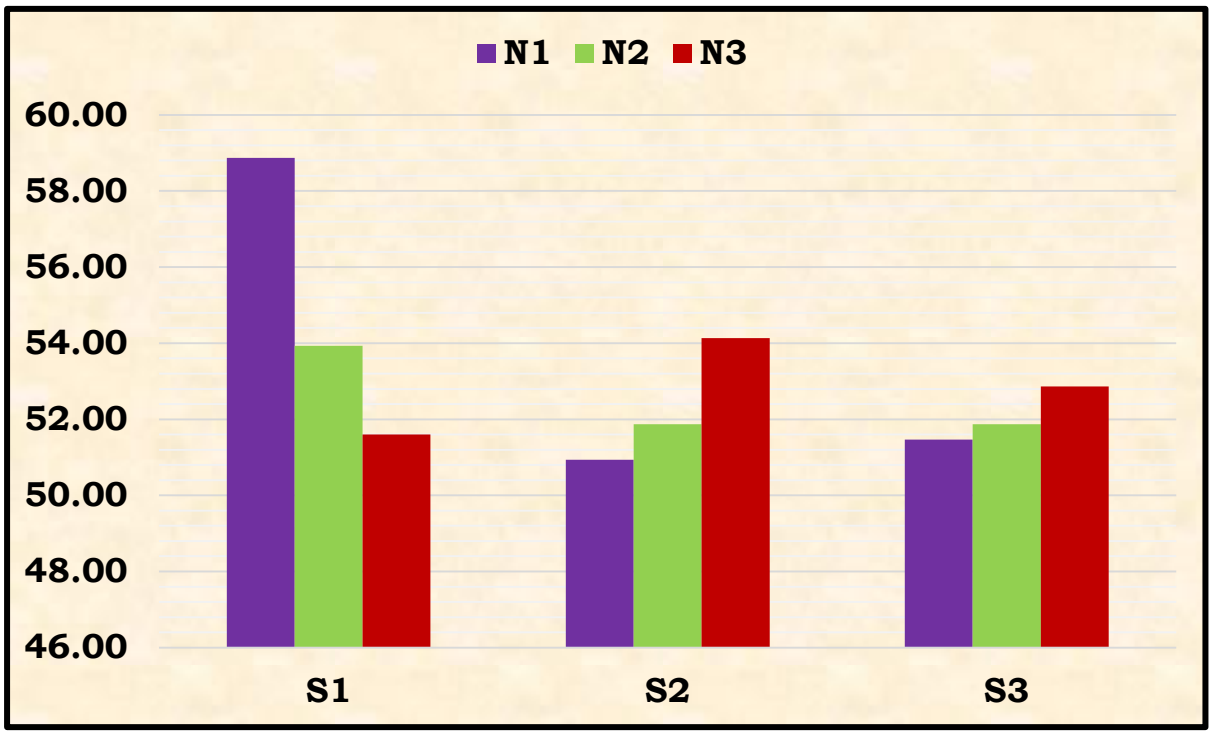


Fig. 8: Effect of spacing, nitrogen and their interactions on duration of harvest of yard long bean

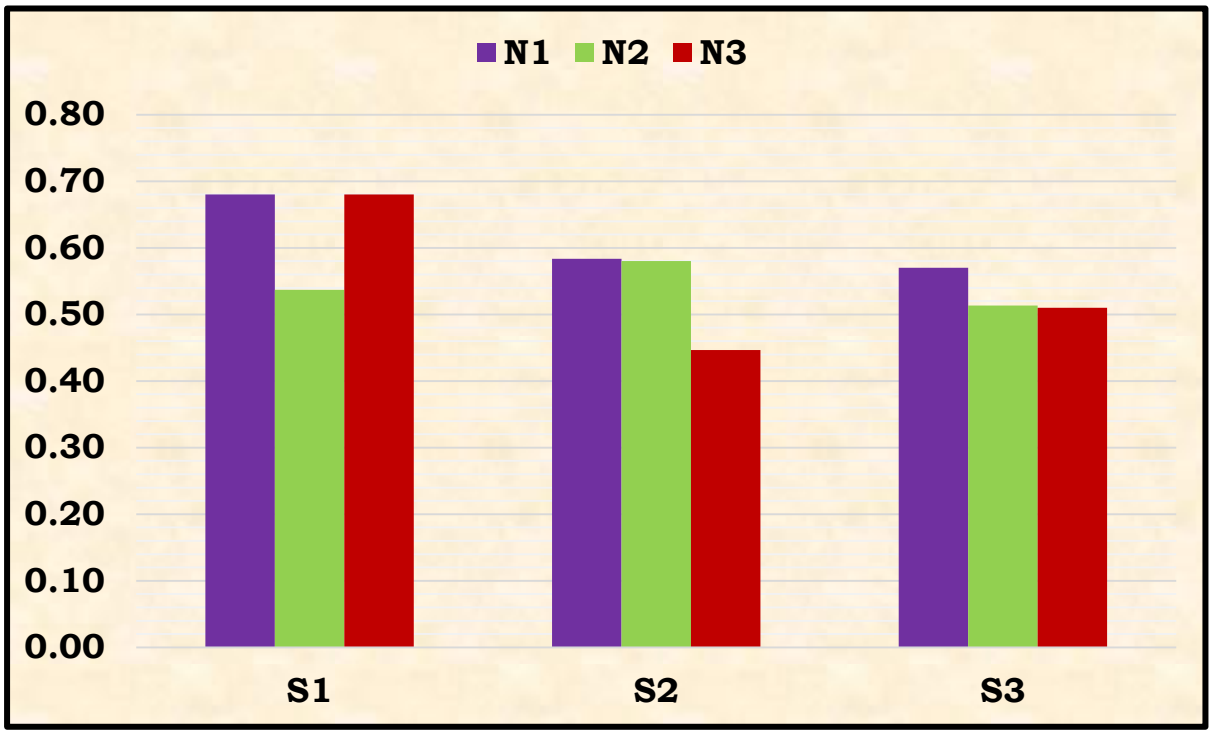


Fig. 9: Effect of spacing, nitrogen and their interactions on green pod yield/plant of yard long bean

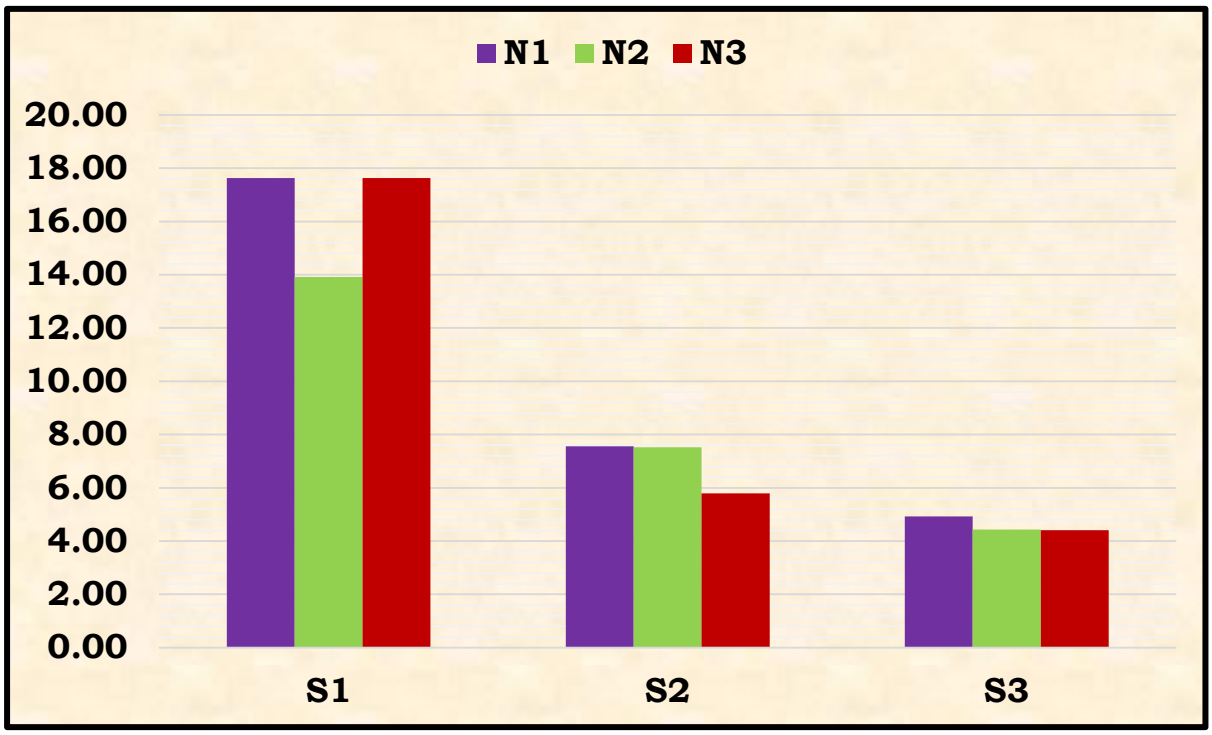


Fig. 10: Effect of spacing, nitrogen and their interactions on pod yield /ha of yard long bean

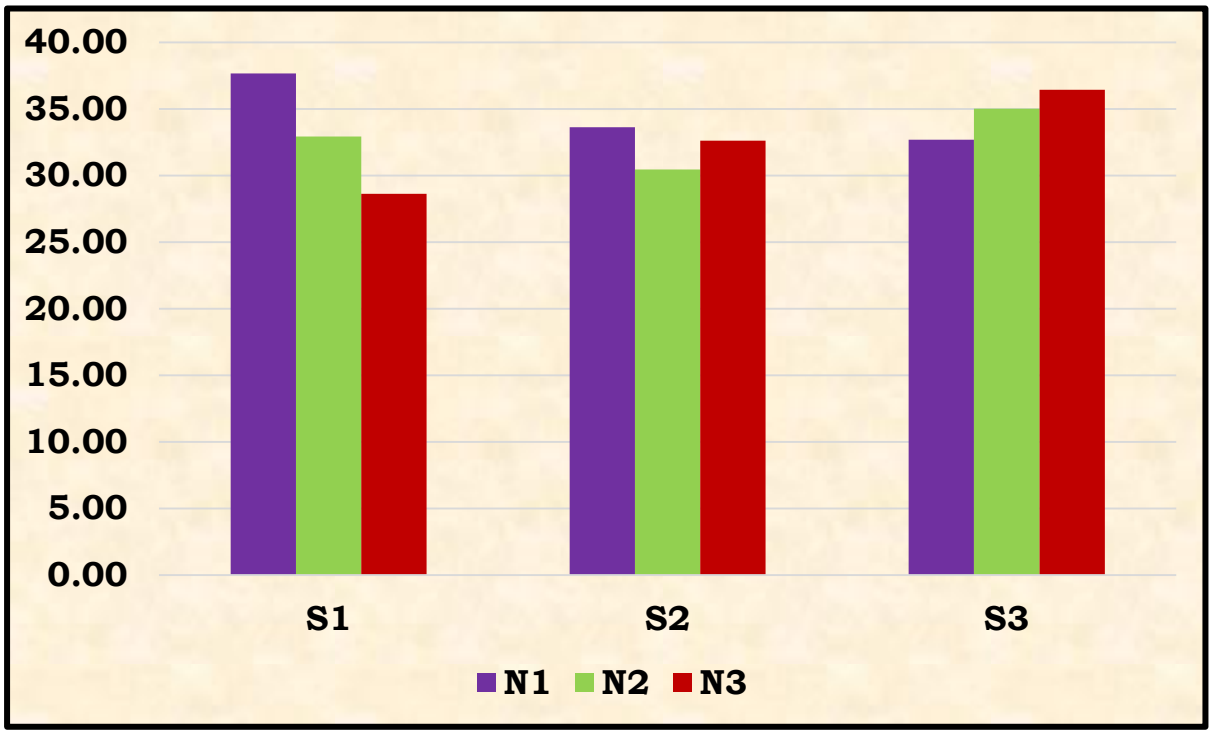


Fig. 11: Effect of spacing, Nitrogen and their interactions on length of pod of yard long bean

APPENDIX II

Weekly Meteorological data of the year

Met. Week	Period	Max. Temp. (^{0}c)	Min. Temp. (^{0}c)	Mean Relative Humidity (%)	Sunshine Hours (hrs/day)
1	01.01 -07.01	34.1	12.7	61.5	8.3
2	08.01 -14.01	32.4	12.9	68	7.6
3	15.01 -21.01	28.9	11.9	66.5	8.5
4	22.01 -28.01	32.0	12.4	59	8.4
5	29.01 -04.02	34.7	12.5	65	8.5
6	05.02 -11.02	29.2	13.0	74.5	8.1
7	12.02 -18.02	29.2	14.0	71.5	8.5
8	19.02 -25.02	32.8	16.8	72.5	8.2
9	26.02 -04.03	33.9	18.7	76.5	6.9
10	05.03 -11.03	34.4	16.1	68	8.2
11	12.03 -18.03	31.4	16.4	73.5	8.7
12	19.03 -25.03	35.7	18.4	74.5	7.9
13	26.03 -01.04	33.7	18.7	76.5	8.2
14	02.04 -08.04	32.9	20.0	77	7.1
15	09.04 -15.04	34.8	20.1	79.5	8.9
16	16.04 -22.04	32.6	21.3	78	8.8
17	23.04 -29.04	33.4	20.3	78.5	9.7
18	30.04 -06.05	33.9	21.0	78	10.0
19	07.05 -13.05	34.3	23.5	78.5	9.2
20	14.05 -20.05	33.5	24.8	78.5	7.2
21	21.05 -27.05	34.2	25.9	74	9.0
22	28.05 -03.06	34.7	25.6	71	9.2
23	04.06 -10.06	34.0	24.8	80.5	3.2
24	11.06 -17.06	31.4	24.9	83.5	4.7
25	18.06 -24.06	29.6	23.1	95.5	1.4
26	25.06 -01.07	27.2	22.6	97.5	0.0
27	02.07 -08.07	28.5	23.6	93	0.2
28	09.07 -15.07	28.4	23.3	92	1.4

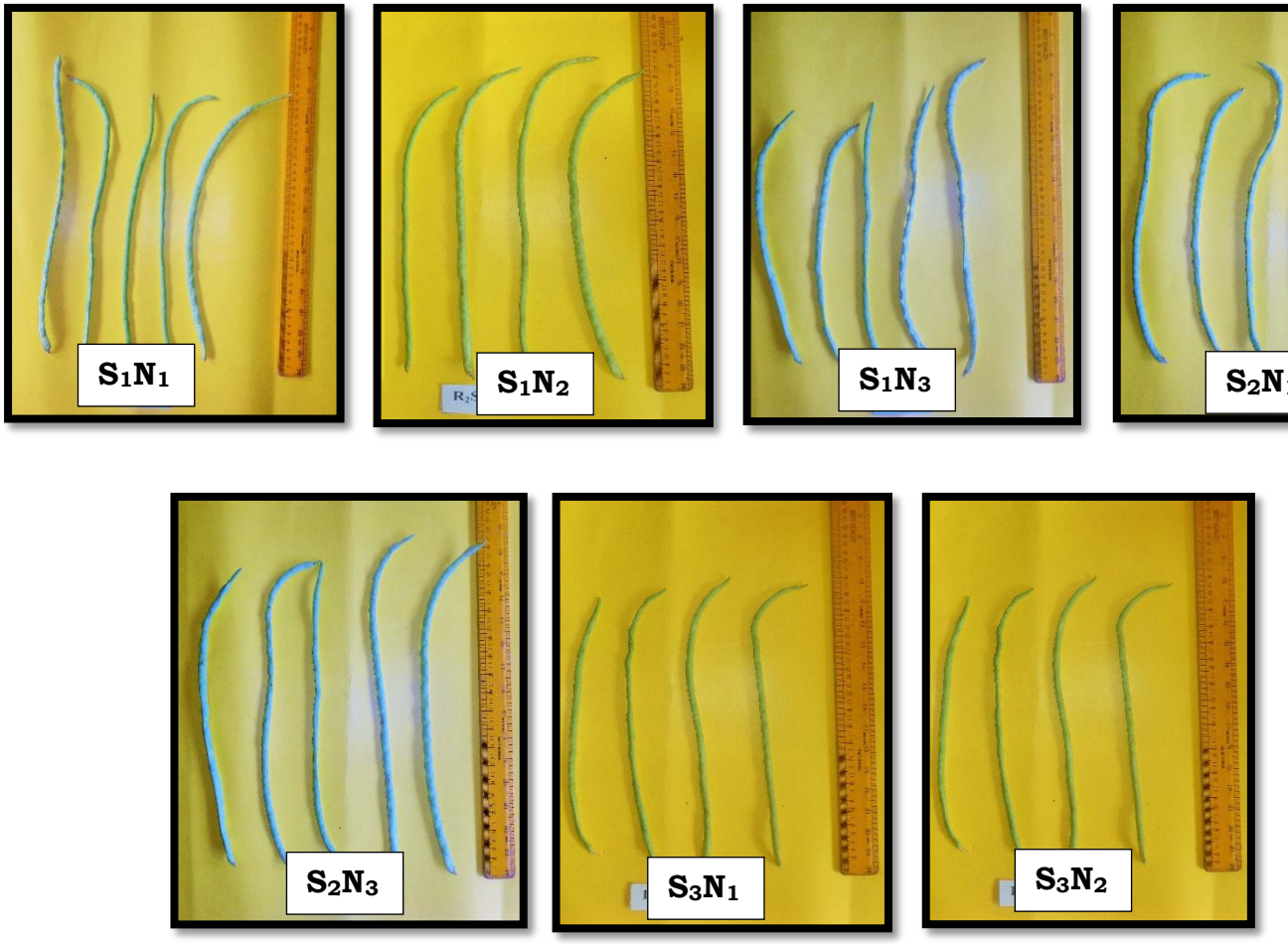


Plate 2:Effect of spacing, nitrogen and their interactions on physical parameters of yard long bean

Main plot (spacing)
S1 = 90 X 30 cm
S2 = 90 X 60 cm
S3 = 90 X 90 cm

Sub plot (fertilizer NPK kg/ha)
F1 = 60:60:30
F2 = 90:60:30
F3 = 120:60:30

Design = Split plot
Replications = 3
Plot size = 2.7m x 3.6 m
Path size = 0.7 m
Variety = Konkan wali

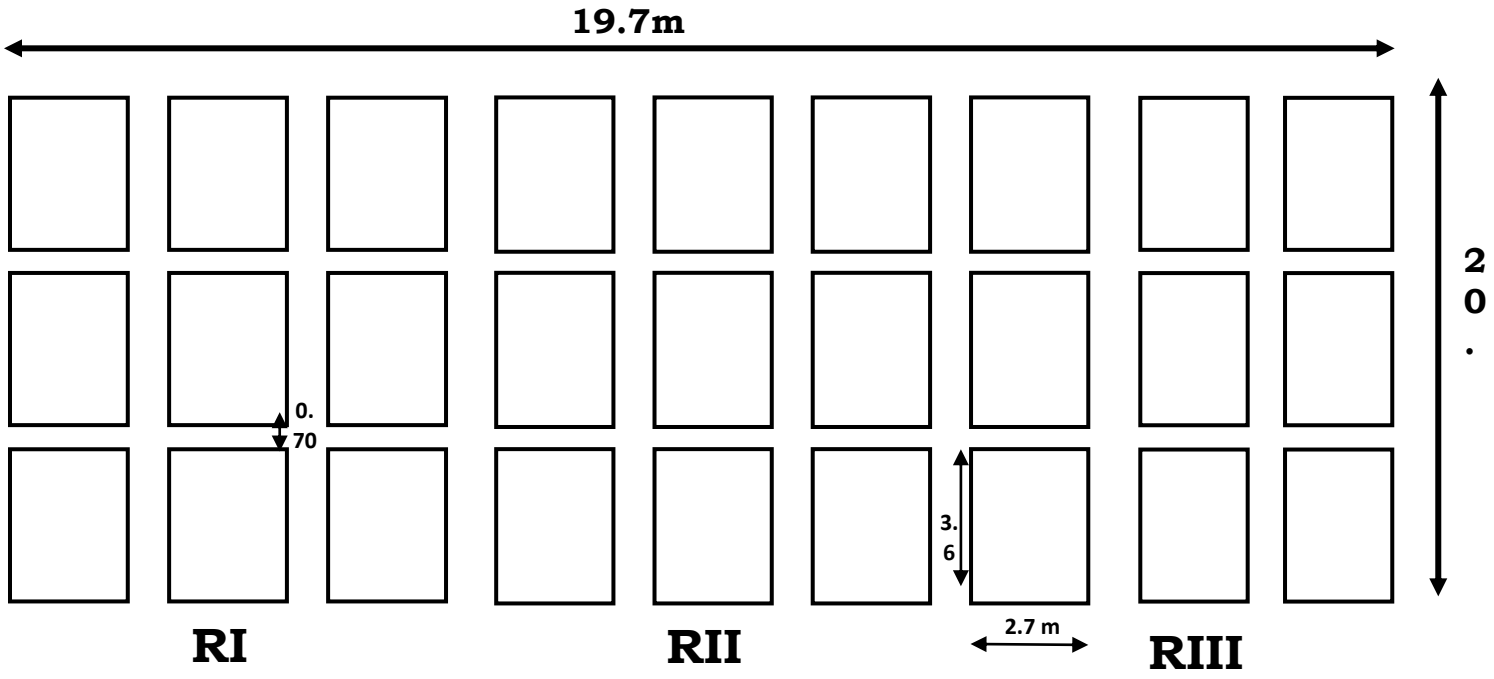
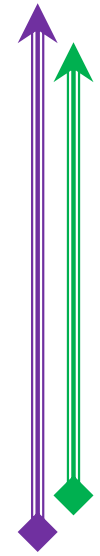


Fig. 1 Experimental plot layout

INTRODUCTION

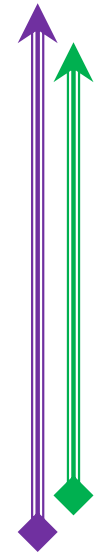
ABSTRACT

ABSTRACT

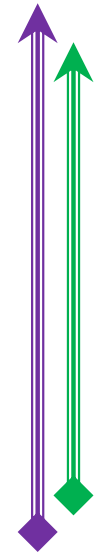


MATERIAL AND METHODS

RESULTS AND DISCUSSION



SUMMARY AND CONCLUSION



LITERATURE CITED

APPENDICES