

**“STUDIES ON GENETIC VARIABILITY FOR
YIELD AND ITS COMPONENTS IN SPINE
GOURD (*Momordica dioica* Roxb.)”**

M. Sc. (Hort.) Thesis

by

Sukwariya Devi

**DEPARTMENT OF VEGETABLE SCIENCE
COLLEGE OF AGRICULTURE
FACULTY OF HORTICULTURE
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (Chhattisgarh)
2019**

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GOURD (*Momordica dioica* Roxb.)”**

Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

Sukwariya Devi

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in

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(Vegetable Science)**

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CERTIFICATE –I

This is to certify that the thesis entitled “**Studies on genetic variability for yield and its components in spine gourd (*Momordica dioica* Roxb.)**” submitted in partial fulfillment of the requirements for the degree of **Master of Science in Horticulture (Vegetable Science)** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur is a record of the bonafide research work carried out by **Sukwariya Devi** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instructions.

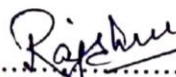
No part of the thesis has been submitted for any other degree or diploma or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by her.


Chairman


Date: 25.07.2019

THESIS APPROVED BY THE STUDENT’S ADVISOR COMMITTEE


Chairman (Dr. Rajshree Gayen)


.....

Member (Dr. R.K. Yadav)


.....

Member (Dr. Jitendra Singh)


.....

Member (Dr. R.R. Saxena)


.....

CERTIFICATE – II

This is to certify that the thesis entitled “**Studies on genetic variability for yield and its components in spine gourd (*Momordica dioica* Roxb.)**” submitted by **Sukwariya Devi** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfillment of the requirements for the degree of **Master of Science in Horticulture (Vegetable Science)** in the **Department of Vegetable Science** has been approved by the external examiner and Student’s Advisory Committee after oral examination.



Signature External Examiner
(Name: Dr. R.K. Sonkar.)

Date: 20/8/19

Major Advisor

Rajshree

Head of the Department

NSL...

Faculty Dean

[Signature]

Approved/Not approved

Director of Instructions

.....

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"... the beauty of the destination is half veiled and the fragrance of the success half dull until the traces of all those enlightening the path are left to fly with the wind spreading word of thankfulness....".

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Department of Vegetable Science
College of Agriculture,
I.G.K.V., Raipur
(Chhattisgarh)
Date:

Sukwariya Devi
Sukwariya Devi

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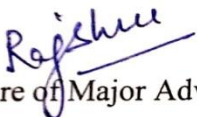
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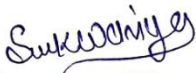
LIST OF ABBREVIATIONS

Abbreviations	Full form
%	Per cent
°C	Degree Celsius
CD	Critical Difference
Cm	Centimeter
CV	Coefficient of variation
Sem	Standard error of mean
Df	Degree of freedom
et. al.	and co-workers / and others
Fig.	Figure
G	Gram
G.A	Genetic Advance
h^2 (b)	Heritability in broad sense
i.e.	That is
Kg	Kilogram
m^2	Square meter
MSS	Mean sum of square
No.	Number
NS	Non significant
PVC	Phenotypic coefficient of variation
GCV	Genotypic coefficient of variation
RBD	Randomized block design
var.	Variety
via.	Through
viz.	For example


THESIS ABSTRACT

- a) Title of the Thesis : “Studies on genetic variability for yield and its components in spine gourd (*Momordica dioica* Roxb.)”
- b) Full Name of the Student : Sukwariya Devi
- c) Major Subject : Vegetable Science
- d) Name and Address of the Major Advisor : Dr. Rajshree Gayen, Associate Professor
College of Agriculture, IGKV, Raipur.
- e) Degree to be Awarded : M.Sc. (Hort.) Vegetable Science


Signature of Major Advisor


Signature of the student

Date: 25.07.2019


Signature of Head of the Department

ABSTRACT

The experimental material comprised of 12 promising genotypes of spine gourd (*Momordica dioica* Roxb.) were sown on 3 July 2018 at Horticulture Instructional Farm, COA, IGKV, Raipur (C.G). The experiment was laid out in Randomized Block Design with three replication.

Results of genetic variability indicated that sum of squares were highly significant due to genotypes for all traits.

Based on mean performance, genotypes like C.G Kankoda-2, RMD 15-2, NDMD 16-1, ASG 16-1 and ASG 18-1 were found higher yielder, early flowering and better growth along with other desirable characters.

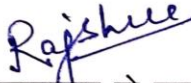
Higher PCV and GCV was observed for fruit yield per plant (49.91%, 49.4%), no. of fruits per plant (29.34%, 28.54%), no. of branches per plant (35.98%, 32.72%), average fruit weight (20.64%, 20.43%) and 100 seed weight (22.89%, 20.99%).

High heritability along with high genetic advance was found for traits viz., fruit yield per plant (97.95%, 97.81%), hundred seed weight (84.11%, 39.67%), no. of fruits per plant (94.60%, 57.19%), average fruit weight (98.04%, 41.69%) and days to first female flower node (95.35%, 30.18%) which indicated predominance of additive gene action.

Correlation coefficient analysis revealed that fruit yield per plant shown a highest positive significant relationship with fruit length (0.461, 0.494), no. of fruits per plant (0.779, 0.800), no. of branches per plant (0.754, 0.825), fruit width (0.535, 0.602) and average fruit weight (0.365, 0.336) at both phenotypic and genotypic levels. Hence, in selection programme, emphasis should be given on these traits for improvement in fruit yield of spine gourd.

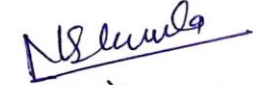
शोधग्रंथ सारांश

- अ. शोध शीर्षक – “कंकोड़ा (मोमार्डिका डायोइका रोक्सब) में उपज एवं इसके घटकों के लिए अनुवांशिकी विभिन्नता का अध्ययन”
- ब. विद्यार्थी का पूरा नाम – सुकवरिया देवी
- स. प्रमुख विषय – सब्जी विज्ञान
- द. प्रमुख सलाहकार का नाम व पता – डॉ. राजश्री गार्डिन (सह-प्रद्यापक) सब्जी विज्ञान विभाग, इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर (छ.ग.)
- य. सम्मानित की जाने वाली उपाधि – एम. एस. सी. (उद्यानिकी) सब्जी विज्ञान


प्रमुख सलाहकार के हस्ताक्षर


विद्यार्थी के हस्ताक्षर

दिनांक : 25.07.2019


विभागाध्यक्ष के हस्ताक्षर

शोधग्रंथ सारांश

कंकोड़ा (मोमार्डिका डायोइका रोक्सब) की बारह अनुकूल जीनप्रारूपों को 3 जुलाई सन् 2018 में उद्यानिकी प्रक्षेत्र, इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर (छ.ग.) में अध्ययन हेतु प्रयोग में लाया गया। प्रयोग को तीन रेप्लिकेशन के साथ यादृच्छिक ब्लॉक डिजाइन में रखा गया था।

अनुवांशिकी विभिन्नता सभी लक्षणों के लिए सभी जीनप्रारूपों में मध्यमान योग वर्ग उच्च सार्थक परिणाम प्रदर्शित करते हैं।

मध्यमान प्रदर्शन के आधार पर कुछ जीनप्रारूप जैसे – छ.ग. कंकोड़ा – 2, आर एम डी – 15-2, एन डी एम डी – 16-1, ए एस जी – 16-1 एवं ए एस जी – 18-1 अधिकतम उपज, जल्दी पुष्पन एवं अच्छी वृद्धि के साथ-साथ दूसरे वांछनीय लक्षणों के लिए पाया गया।

पैतृक मतभेद मान गुणांक एवं बाह्य मतभेद मान गुणांक, फल उपज प्रति पौधा (49.91%, 49.40%), फलों की संख्या प्रति पौधा (29.34%, 28.54%), शाखाओं की संख्या प्रति पौधा (35.98%, 32.72%), औसत फल वनज (20.64%, 20.43%), एवं एक सौ बीजों का वजन (22.89%, 20.99%), के लिए अधिकतम आंका गया।

सर्वाधिक वंशागतित्व के साथ-साथ अनुवांशिक उन्नति (प्रतिशत), फल उपज प्रति पौधा (97.95%, 97.81%), एक सौ बीजों का वनज (84.11%, 39.67%), फलों की संख्या प्रति पौधा (94.60%, 57.19%), औसत फल वनज (98.04%, 41.69%) एवं प्रथम मादा पुष्पन गांठ (95.35%, 30.18%) के लिए पाई गई जो योगात्मक अनुवंश क्रिया को संकेत देती है।

सह-संबंध गुणांक के अध्ययन से पता चलता है कि फल उपज प्रति पौधा के साथ फलों की लंबाई (0.461, 0.494) शाखाओं की संख्या प्रति पौधा (0.754, 0.825), फलों की संख्या प्रति पौधा (0.779, 0.800), फलों की मोटाई (0.535, 0.602) एवं औसत फल वजन (0.365, 0.336) के लिए सकारात्मक एवं सार्थक सह-संबंध पैतृक एवं बाह्य स्तर पर देखा गया। अतः इन लक्षणों के आधार पर कंकोड़ा में अधिकतम हरे फल उपज के चुनाव पर जोर देना चाहिए।

CHAPTER I

INTRODUCTION

Spine gourd (*Momordica dioica* Roxb. $2n=28$) is an important member of family of cucurbitaceae. It is a nutritionally rich, dioecious and perennial cucurbit having a wide range of suitability, distributed throughout India, China, Nepal, Pakistan, Sri Lanka and Bangladesh (Rai, *et al* 2012). It is originated from Indo-Malayan region (Rashid, 1976). It is widely cultivated in Odisha, Maharashtra, Bihar, Jharkhand, West Bengal and Chhattisgarh. The exact information about acreage and production data is not yet known even Chhattisgarh also. However, as a rhizomatous crop, it is estimated as having high green fruit yield 29.47 q/ha in Chhattisgarh (Yadav, 2018).

Spine gourd is economically important vegetable plant with high food and medicinal value, cultivated for its fruits, which is used as vegetable and is known by various names such as Kankoda, Kheksi, Teasle gourd, Kakrol, Kantola, Meetha Karela and Kantroli. Green fruit of spine gourd per 100 g eaten part, hold moisture 84.0g, fat 0.9 g, fibre 2.9 g, carbohydrates 7.6 g, carotene 161 mg, protein 3.2 g, calcium 32 mg, phosphorus 43 mg, iron 4-7 mg, thiamine 0.06 mg, riboflavin 0.19 mg and niacin 0.05 mg (Ram *et al.*, 2004). The young leaves of spine gourd are also consumed as leafy vegetable. The seeds of spine gourd contains oil and oil is used as an illuminant. This popular vegetable has high demand in the market due to its nutritional and medicinal value, high keeping quality, ability to withstand long distance transportation, high market price and good export potential (Rasul, 2003).

Fruits causes increase in urination, preservative against the effects of poison anti hepatotoxicity and have antivenum property. It is used to help to cure asthma, leprosy, prevent the inflammation caused by lizard, snake bite, fever, mental and digestive disorders. Fresh fruit juice is advised for hypertension. Its fruits are prepared by heating in a small amount of oil and can be eaten to cure diabetes. Green fruits are may be apply on skin to cure pimples. Seeds are cooked and used for eczema and other skin disorders. Young leaves of the plant are anti parasitic. Liquid of roots raises levels of physiological activities in the body. The

gelatinous tubers kills spermatozoa, reduce fertility causing abortion and urinal problems. Dry particles of roots can be applied to skin for softness and reduce sweating. The cooked roots are applied to stop process of losing blood flow from haemorrhoids and also in intestine accusation (Baratakke *et al.*, 2013). In India, research work on spine gourd is co-ordinated by NBPGR, ICAR, New Delhi, through All India Co-Ordinated Research Network on Potentials Crops running at one of them five centres in various states including Chhattisgarh also of the Nation.

Stem slender, glabrous to rarely sparsely pubescent angled. Tendrils are elongated, simple, straight and glabrous. Leaves are much variable, ovate or acute and mucronate, lobes triangular, length varies from 3.2-8cm, heart shaped at the base, extremely lobed, punctuated, petiole 1.3-4.5 cm long furrows above, covered with soft hair and gland . Male flowers are solitary, up to 2.8 cm long glabours peduncles which are hairy, corolla yellow. Female flowers are bracteates or ebracteates. Petals 1.3 -2.5 cm long, rectangular. Calyx 5 linear lanceolate. Corolla 5 and stamens 3. Female flower is alone, calyx and corolla as in male without its anthers, ovary uncovered with long soft, small rounded and many ovule. Fruits of Kankoda are nibbled, thick with inner red meat with soft spine. Seeds are rounded broadly solid, slightly compact and irregularly wrinkle enclosed in red pulp.

Spine gourd exhibits huge diversity in shape, size of leaf, fruit shape and fruit colour. As this crop is highly cross pollinated, showed high genetic variation. The male plant of spine gourd does not produce any fruit; it is difficult to judge its yield performance. Improvement of this crop has been not attempted much, due to its dioecious nature and mode of propagation. Kankoda has a number of problems related to its low fruit yield and small sized fruit, low bearing, lack of synchronized male and female plants, regular hand pollination and appearance of number of rigid seeds in the fruit. Lower rate of rhizome production, sprouting of seedling of seeds are very low due to hard seed coat (Rashid 1976).

Advancement can be done in this crop based on the genetic variability available in the genotypes. High values of heritability estimates indicate the potentiality for significant improvement using standard selection strategy. Heritability estimates accompanied with genetic advance are more useful in selection of superior genotypes. In plant breeding, improvement in economic

characters frequently depends on the availability of large genotypes represent a diverse genetic variation. Knowledge of the correlation between green fruit yield and its attributing characters will be of considerable value in designing a breeding programme. Systematic breeding efforts on this crop so far have been neglected. The success of any breeding programme depends on the quantum of genetic variability for exploitation, the genetic coefficient of variation together with the heritability estimates, genetic advance and correlations among different traits with fruit yield. Therefore, an experiment was framed out to study the different genotypes collected from different places like NDUAT, Faizabad, RMD CARS, Ambikapur and College of Agriculture, IGKV, Raipur, Chhattisgarh under All India Co-ordinated Research Network Project on Potential Crops with the following purposes:

1. To calculate genetic variability, heritability and genetic advance for green fruit yield and its contributing characters in spine gourd.
2. To find out the correlation coefficient among fruit yield and its components in spine gourd.

CHAPTER II

REVIEW OF LITERATURE

Spine gourd (*Momordica dioica* Roxb.) is a one of the most important members of the cucurbitaceae, which is dioecious in nature and green fruit contains carbohydrate, protein, fat, fibre and minerals. Very little information is available on the aspect of genetic variability for fruit yield and its components in spine gourd. Hence, the available research findings related with the present investigation on spine gourd have been reviewed and presented below under the following heads;

2.1 Genetic Variability

2.2 Heritability and Genetic Advance

2.3 Correlations

2.1 Genetic Variability

Genetic variability in any population is one of the most important characteristics and distinctive feature. For improvement of the crop plant population with higher variability provides greater opportunity. Hence, in population present among the genotypes it is important to study and utilize the existing variability. The genetic variability for various characters has been studied by several workers in spine gourd.

Maharana *et al.*, (1995) reported that genetic variability was measure among thirty four genotypes of spine gourd. Information about variability and heritability is derived from data on internode length, weight of the fruit, total fruit yield per plant and number of green fruits per plant in these genotype grown. Maximum variability was noticed for the characters like total number of fruits per plant and yield of fruit per plant.

Ram *et al.*,(2004) reported variability in spine gourd. They found that the widest range for length of the fruit while narrowest range was observed for days to female flower anthesis. Maximum variability expressed by the characters like days to anthesis of female flower, length of the fruit, height of the plant, diameter of the

fruit, fruits number per plant and yield of fruit per plant at phenotypic and genotypic level. Genetic advance were high for number of branches per plant and yield of fruit per plant.

Bharathi *et al.*, (2006) assessed genetic variability in thirty two genotypes of spine gourd (*Momordica dioica* Roxb.). The characters like number of nodes on which first flower appear, days to flowering, length of the fruit, length of the vine, internode length, weight of the fruit, number of fruits and fruit yield per plant. PCV ranged from 15.26% for fruit girth to 34.28% for fruit weight and GCV ranged from 14.38% for fruit girth to 33.52% for fruit weight.

Panchbhai *et al.*, (2006) reported genetic variability among 113 *Momordica dioica* genotype collected from different parts of India. Eleven yield characters were evaluated like length of the vine, number of branches per plant, days to initiation of flowering, weight of the fruit, yield of fruit per plant and number of seeds per fruit. They obtained maximum variations in characters like length of the vine, days to initiation of flowering, number of green fruits per plant, weight of the fruit and yield of fruits per plant.

Rahman *et al.*, (2011) evaluated fourteen quantitative and two qualitative components of sweet gourd. They found significant differences for all the characters investigated. High GCV and PCV values were noticed for characters like total yield of fruit per plant and weight of the fruit.

Naik *et al.*, (2012a) reported estimate the genetic variability in teasel gourd. They found significant differences for all the characters investigated. High PCV were recorded for weight of the fruit and fruit breadth.

Basumatary *et al.*, (2014) noticed a wide range of variation among the fifteen genotypes for all the characters. High GCV and PCV value were recorded for yield of fruit per plant, length of the vine, single weight of the fruit and number of seeds per fruit.

Chattopadhyay *et al.*, (2016) conducted a study to measure the genetic variability among eleven genotypes of teasel gourd. High PCV and GCV values were noticed for the characters like internode length, diameter of the fruit, weight of the fruit, number of fruits per plant and yield of fruit per plant except days to maturity.

Prabhakar *et al.*, (2017) exhibited the widest range of variability for yield of fruit per plant and number of green fruits per plant, while narrowest range was observed for fruit rind thickness. The characters like length of the fruit, number of shoots per plant, fruiting period and average weight of the fruit expressed maximum variability.

Yadav (2018) conducted a study to estimate genetic variations in thirty one female clones of spine gourd. He found a wide range of variability for the traits like internode length, yield of fruits per plant, days to last fruit harvest, days to first fruit harvest and number of fruits per plant except length of the fruit and width of the fruit in the germplasm lines collected from different zones of Chhattisgarh state.

2.2 Heritability and Genetic advance

The heritability is an index for transmission of any characters from parents to their offspring. This concept of heritability is important for determination of phenotypic differences are due to variation in their genotypic characters or simply as a result of environmental factors among various individuals. An improvement in the mean genetic value in the new population over the parental population is the Genetic advance.

Bharathi *et al.*, (2006) found high heritability for all characters under study except length of the vine. High heritability accompanied with high genetic advance as percentage of mean for characters like individual weight of the fruit and number of fruits per plant. Genetic advance ranged from 25.88% to 67.51% in thirty two genotypes of spine gourd.

Singh *et al.*, (2009) evaluated eighteen genotypes of spine gourd collected from natural growing forest. Growth parameters like the number of green fruits per plant and yield of fruit per plant exhibited high heritability coupled with high genetic advance as a percent of mean.

Rahman *et al.*, (2011) described high heritability coupled with low genetic advance for most of the characters under study. High heritability coupled with exceptional high genetic advance was found for total fruit yield per vine in eleven genotypes of sweet gourd.

Naik *et al.*, (2012b) reported that “weight of the fruit, number of fruits per plant, length of vine, number of vines per plant exhibited high heritability coupled with high genetic advance in five female clones of teasel gourd”.

Chattopadhyay *et al.*, (2016) confirmed that high heritability accompanied with high genetic advance for number of fruits per plant and yield of fruit per plant. High heritability with low genetic advance as percentage of mean for days to flowering, internode length, length of the fruit, diameter of the fruit and weight of the fruit in spine gourd.

Archana *et al.*, (2017) studied genetic variability in 31 accessions of spine gourd and found that GCV and PCV value was higher for the characters like days to flowering, days to maturity, total number of fruits harvest and length of the fruit.

Yadav (2018) found that PCV was higher than the GCV for all the traits in local germplasm line of spine gourd. High heritability coupled with high genetic advance as percentage of mean was exhibited for days to last fruit harvest, internode length, yield of fruit per plant and days to first fruit harvest.

2.3 Correlations

Selection is based on the association of characters which is statistically analysed by correlation coefficient. The relationship of one character with the other character is the study of Correlation. Through correlation coefficient the degree of associations between any character and its contributors can be estimated at genotypic and phenotypic levels. The range of Correlation coefficient is lies between (-1) and (+1) where (-1) represent a perfect negative correlation, +1 is a perfect positive correlation and a value of 0.0 represent lack of correlation. For formulating and executing the breeding programme, understanding the association of yield and its components are important. The literature available on correlations studies in spine gourd is reviewed as follows:

Puzari (1999) found positive correlation between the seed weight and number of seeds per fruit in spine gourd.

Rasul *et al.*, (2004) studied twenty nine Kakrol(*Momordica dioica* Roxb.) accessions and its one wild relative collected from different agro-ecological zone of Bangladesh. They found considerable variations for the characters of length of

the vine, number of branches per plant, fruiting period, internode length, length of the fruit and diameter of the fruit.

Rahman *et al.*, (2011) evaluated genotypic and phenotypic correlation in eleven genotypes of sweet gourd and revealed that total fruit yield per vine was significantly and positively correlated with fruit length, weight of the fruit and diameter of the fruit.

Aliya *et al.*, (2014) evaluated fifty genotypes of spine gourd and revealed that the green fruit yield per plant was significant positive correlated with the number of stems per plant, length of the vine, days to last fruit harvest, fruiting period, length of the fruit, width of the fruit, weight of the fruit and number of green fruits per plant. Significant negative correlation between days to first fruit harvest and total green fruit yield per plant was also observed.

Basumatary *et al.*, (2014) carried out association study in spine gourd and reported that length of the vine is highly correlated with internode length, diameter of the fruit and 100 seed weight. Highly significant and positive correlation was also observed between total number of fruits per plant and yield of fruit per plant and length of the fruit with single weight of the fruit.

Chattopadhyay *et al.*, (2016) observed significant positive genotypic correlation for number of fruits per plant and internode length with yield of fruit per plant. Yield of fruits per plant also exhibited positive and significant phenotypic correlations with weight of the fruit and diameter of the fruit. Negative significant correlation between length of the fruit and yield of fruit per plant has also been observed.

Archana *et al.*, (2017) described that yield of fruit per plant was significantly correlated with number of branches per plant, total number of fruits harvest and length of the fruit in spine gourd accessions.

Prabhakar *et al.*, (2017) observed that green fruit yield per plant had significantly positive correlation with days to appearance of first female flower, fruiting period, length of the fruit, weight of the fruit, fruit width, thickness of fruit, number of seeds per fruit, number of fruits per plant. Significant negative correlation between days to anthesis and days to fruit maturity.

CHAPTER –III

MATERIALS AND METHODS

3.1 Experimental Site, Location and Climate

The present experiment entitled “**Studies on genetic variability for yield and it’s components in spine gourd (*Momordica dioica* Roxb.)**”. The field experiment was laid out during the 2018 *Kharif* season in the experimental area of the Department of Genetics and Plant Breeding at the Horticulture Farm, IGKV, Raipur. Raipur is located at 20.16°N, latitude in the Central Eastern part of Chhattisgarh, 81.36°E longitude and 289.5 m above mean sea level (MSL).

The general climatic conditions of Raipur are classified as sub-humid with a hot summer and a cold winter. The average annual precipitation of the region is 1200-1400 mm, most rainfall (85%) occurs from June to September. In Raipur, the average maximum and minimum temperatures during the growing periods of crops 41.8°C and 12.4°C respectively, while the hottest and coldest months are May and December, respectively, as recorded in the Department of Agricultural Meteorology Observatory, Faculty of Agriculture, IGKV, Raipur.

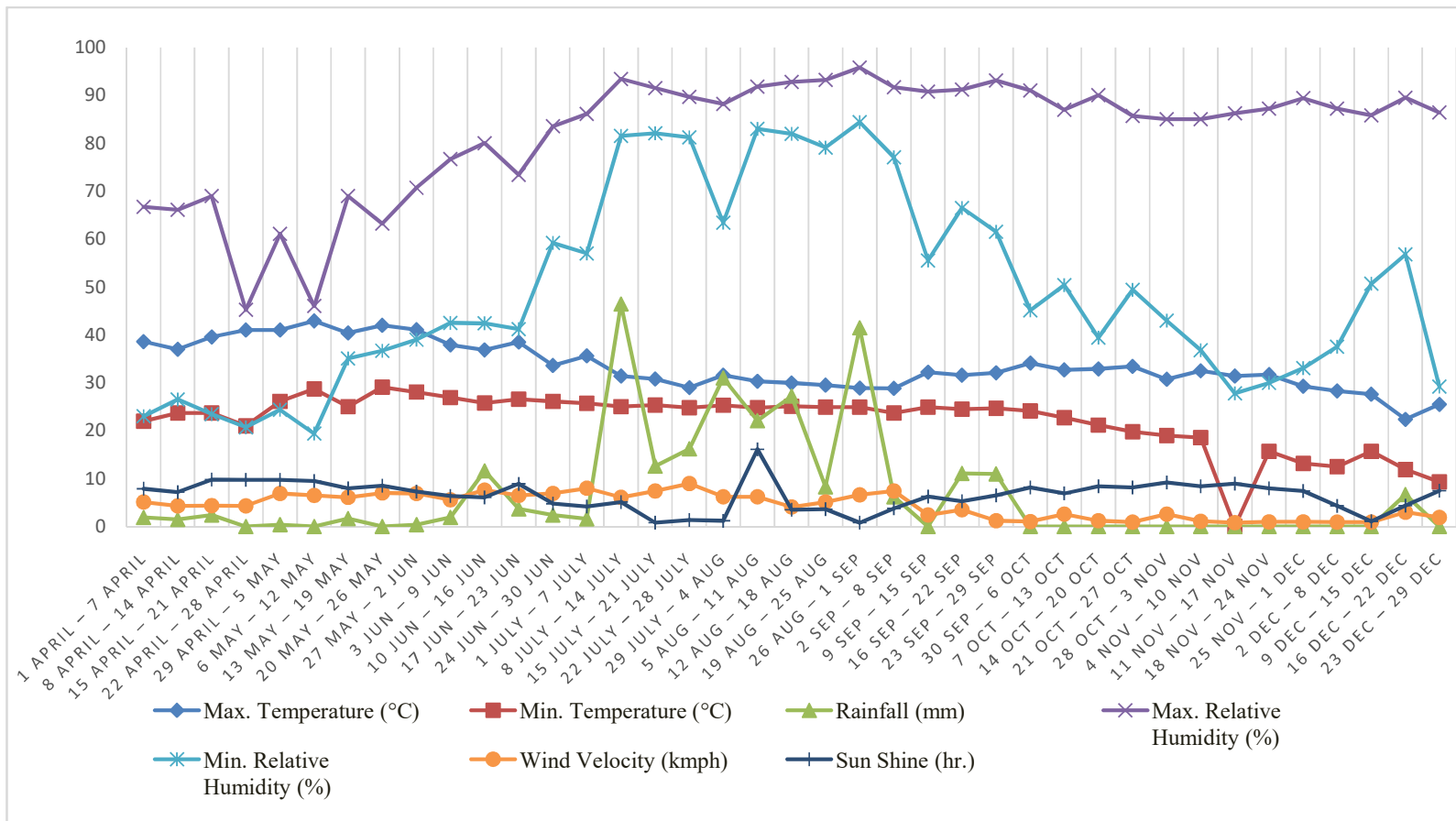


Fig 3.1: Weekly meteorological data during crop growing period 2018

3.2 Experimental Materials

Twelve promising genotypes including National checks were evaluated during *Kharif* season of 2018. All these genotypes were obtained from Raj Mohini Devi College of Agriculture and Research Station, Ambikapur (C.G.), Narendra Dev University of Agriculture and Technology, Faizabad (U.P.) and Main campus (Voluntary centre) College of Agriculture, IGKV, Raipur.

Table 3.1 An experimental materials and their sources;

Sl. No.	Name of genotypes and checks	Source of genotype
1.	ASG 18-1	RMD CARS, Ambikapur (C.G.)
2	ASG 18-2	RMD CARS, Ambikapur (C.G.)
3	ASG 18-3	RMD CARS, Ambikapur (C.G.)
4	ASG 18-4	RMD CARS, Ambikapur (C.G.)
5	ASG 18-5	RMD CARS, Ambikapur (C.G.)
6	ASG 16-1	RMD CARS, Ambikapur (C.G.)
7	Indira Kankoda-1 (check)	College of Agriculture, IGKV, Raipur (C.G.)
8	RMD SG-3	RMD CARS, Ambikapur (C.G.)
9	NDMD – 16	NDUAT, Faizabad, Uttar Pradesh
10	NDMD-16-1	NDUAT, Faizabad, Uttar Pradesh
11	CG Kankoda -2 (check)	College of Agriculture, IGKV, Raipur (C.G.)
12	RMD 15-2	College of Agriculture, IGKV, Raipur (C.G.)

3.3 Details of treatment

R-I	R-II	R-III	Treatment Details
T ₁	T ₁₂	T ₅	T ₁ ASG 18-1
T ₂	T ₁₁	T ₆	T ₂ ASG 18-2
T ₃	T ₁₀	T ₇	T ₃ ASG 18-3
T ₄	T ₉	T ₈	T ₄ ASG 18-4
T ₅	T ₈	T ₉	T ₅ ASG 18-5
T ₆	T ₇	T ₁₀	T ₆ ASG 16-1
T ₇	T ₆	T ₁₁	T ₇ Indira Kankoda-1(C)
T ₈	T ₅	T ₁₂	T ₈ RMD SG-3
T ₉	T ₄	T ₁	T ₉ NDMD 16
T ₁₀	T ₃	T ₂	T ₁₀ NDMD 16-1
T ₁₁	T ₂	T ₃	T ₁₁ C.G Kankoda-2 (C)
T ₁₂	T ₁	T ₄	T ₁₂ RMD 15-2



Fig 3.2: Layout of Experimental field

3.4 Experimental Design

The crop was raised in “Randomized Block Design” with 3 replications. Each genotype and checks was sown in plot size of 1m × 1m. Biometric observations were recorded. All the recommended agronomical package of practices were followed to facilitate better crop growth.

3.5 Observations recorded

Observations were recorded at the blooming stage of the crop for 15 characters on five randomly selected competitive plants in each plot.

3.5.1 Vine length (cm)

Length of vine was taken from the base ground level to the tip of the inflorescence and measured in centimeters.

3.5.2 Number of branches per plant

It was counted after establishment of vines at vegetative stage.

3.5.3 Internode length (cm)

It was measured using scale and mean was expressed in centimetres.

3.5.4 Days to first female flower appearance

Total number of days was recorded from the date of sprouting to the first appearance of female flowers in a plot at flowering stage.

3.5.5 Days to first female flowering node

Number of days was taken from the date of sprouting of seed to the first female flower appearance.

3.5.6 Days to first fruit harvest

It was recorded on the basis of number of days taken from the date of sprouting of the plant.

3.5.7 Days to last fruit harvest

It was recorded on the basis of days taken from the date of germination to the last harvest.

3.5.8 Number of fruits per plant

Total number of marketable healthy green fruits of each repeated treatments were recorded and divided with total number of plants in fruiting period.

3.5.9 Fruiting period

It was recorded by counting the numbers of day from days to first fruit harvest to days to last fruit harvest.

3.5.10 Fruit length (cm)

Fruits were picked at edible maturity stage and measured by Scale.

3.5.11 Fruit width (cm)

Green fruits picked at maturity stage and measured by vernier callipers.

3.5.12 Average fruit weight (g)

Five fruit weight was taken by weighing balance at edible maturity stage and expressed in grams.

3.5.13 Number of seeds per fruit

Fruits were picked from harvested green fruits and their dried seeds were counted.

3.5.14 100 seed weight (g)

100 dried seeds were counted and weighed and expressed in grams.

3.5.15 Fruit yield per plant (g)

Weight of total green fruits from each replication was recorded and averaged by dividing with number of fruit bearing plants.

3.6 Statistical analysis

3.6.1 Analysis of variance (ANOVA)

The average values of the characters mentioned above in the repetitions were taken for ANOVA. Analysis of variance was performed according to Singh and Chaudhary (1985).

Source of variation	Df	Mean sum of squares	Expected Squares
Replications	(r-1)	Mr	$\sigma^2_e + \sigma^2_r$
Treatments	(t-1)	Mt	$\sigma^2_e + r\sigma^2_t$
Error	(r-1)(t-1)	Me	σ^2_e

Where,

r = number of replications

t = number of treatments

σ^2e = error variance
 M_r = mean sum of squares of replications
 M_t = mean sum of squares of treatments
 M_e = mean sum of squares of error

$$\sigma^2g = \text{genotypic variance} = \left(\frac{M_t - M_e}{r} \right)$$

$$\sigma^2p = \text{phenotypic variance} = \sigma^2g + \sigma^2e$$

3.6.2 Mean

It was estimated by following formula:

$$\text{Mean } (\bar{x}) = \frac{\Sigma X}{N}$$

Where,

ΣX = Sum of all the observations

N = Total number of observations

3.6.3 Range

It is the difference between highest and lowest value of observations.

3.6.4 Variability

The method suggested by Burton and De Vane (1953) estimated genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV).

3.6.4.1 Genotypic coefficient of variation

$$\text{GCV (\%)} = \frac{\sqrt{\sigma^2g}}{\bar{X}_i} \times 100$$

Where,

σ^2g = genotypic variance

\bar{X}_i = mean of observation of i^{th} character

3.6.4.2 Phenotypic coefficient of variation

$$\text{PCV (\%)} = \frac{\sqrt{\sigma^2p}}{\bar{X}_i} \times 100$$

Where,

σ^2p = phenotypic variance

\bar{X}_i = mean of observation of i^{th} character

PVC and GCV values were categorized as low, moderate and high as suggested by Shivsbramanian and Menon (1973) which is as follow:

0-10 % = low

10-20% = medium

>20% = high

3.6.5 Heritability (Broad sense):

Formula suggested by Lush (1949).

$$\text{Heritability } h^2(\text{bs}) = \frac{\sigma^2g}{\sigma^2P} \times 100$$

Where,

σ^2g = Genotypic variance

σ^2p = Phenotypic variance

Heritability estimates were classified as low, medium and high as suggested by Allard (1999) which is as follows:

<50% = low

50-70% = moderate

>70% = high

3.6.6 Genetic advance

Formula suggested by Johnson *et al.* (1995)

$$\text{Genetic advance (GA)} = i\sigma p h^2$$

Where,

i = selection intensity at 5% i.e 2.06

σp = phenotypic standard deviation

h^2 = heritability in broad sense

3.6.7 Genetic advance as percentage of mean

$$\text{G.A (\%)} = \frac{G.A}{\bar{X}} \times 100$$

Where,

\bar{X} = general mean of the population

Genetic advance as % of mean was categorized as follows;

<25% = low

25-40% = moderate

>40% = high

3.6.8 Correlation coefficient

Correlation coefficient (r) is the association between two variables. It was estimated using Searle (1961) formula.

$$r_{(xy)} = \frac{\text{Cov}(x,y)}{\sqrt{\text{var}(x) \cdot \text{var}(y)}}$$

Where,

$r_{(xy)}$ = correlation coefficient between variable x and y

$\text{var}(x)$ = variance of x variable

$\text{var}(y)$ = variance of y variable

$\text{cov}(xy)$ = covariance between variable x and y

The coefficients of phenotypic and genotypic correlation were estimated by substituting corresponding variance and covariance in the above mentioned formula..

3.6.9 Significance of correlation

't' test is performed to test the significance of correlation coefficients 't' value were calculated by using the following formula;

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

By comparing 't' value at (n-2) d.f tested the significance of (r). If calculated value of 't' is greater than the tabular value of 't' at (n-2) d.f., the correlation coefficient is considered as significant.

CHAPTER – IV

RESULTS AND DISCUSSION

The results of the present experiment entitled “**Studies on genetic variability for yield and its components in spine gourd (*Momordica dioica* Roxb.)**” discussed here under are as follows:

4.1 “Variance and mean performance analysis”

4.2 “Genetic parameters of variation”

4.3 “Correlation Coefficient analysis”

4.1 Variance and mean performance analysis

The mean value of twelve genotypes is presented in the Table 4.1. ANOVA conducted for fruit yield and its various traits described the sum of squares were highly significant due to genotypes for all traits except length of internode, length of fruit and width of fruit. Significant mean squares owing to fruit yield and its attributing characteristics showed significant variability in the material studied to advancement of different traits.

4.2 Genetic parameters

The genetic parameters of variability for its various components are described in Table 4.2. The general mean for various characters have shown that most of the genotype studied has sufficient genetic variability for most characters. The genetic parameters of the variation are described with character wise.

4.2.1 Mean and range

4.2.1.1 Vine length (cm)

Range for length of the vine was vary between 97.33 cm to 136.33 cm with an average value of 115.63 cm, the genotype ASG 18-1(136.33cm) was found with maximum vine length followed by C.G Kankoda-2(123.33cm) Whereas, the genotype NDMD 16-1 recorded minimum length of vine (97.33 cm). Similar findings were also reported by Ram *et al.*(2004).

Table 4.1 ANOVA for fruit yield and its components in spine gourd.

Sl. No.	Characters	Source of variation		
		Replication (2)	Treatment (11)	Error (22)
1.	Vine length (cm)	31.36**	309.48**	26.42
2.	No. of branches plant ⁻¹	0.69	21.84**	1.42
3.	Internode length(cm)	0.03	0.72	0.10
4.	Days to first female flower Appearance	3.08*	100.18**	2.56
5.	Days to first flowering node	0.52	89.90**	1.43
6.	Days to first fruit harvest	84.36**	204.93**	13.81
7.	Days to last fruit harvest	13.36**	154.89**	2.84
8.	No. of fruits plant ⁻¹	3.44**	311.42**	5.80
9.	Fruiting period	2.77*	243.66**	3.50
10.	Fruit length(cm)	0.01	0.46	0.02
11.	Fruit width(cm)	0.01	0.17	0.02
12.	Average fruit weight(g)	0.00	6.81**	0.04
13.	No. of seeds per fruit	0.02	15.96**	4.57
14.	100 seed weight(g)	1.65	16.49**	0.97
15.	Fruit yield plant ⁻¹ (g)	11.22**	3464.56**	24.00

** Significant at 1% level

* Significant at 5% level

4.2.1.2 No. of branches per plant

Recorded range for this trait was found 4.66 to 14.33 with a mean value of 7.97plant⁻¹. It is were observed maximum in C.G Kankoda-2 (14.33) followed by RMD 15-2 (12) whereas, minimum of branches i.e 4 plant⁻¹ was reported in case of genotypes i.e RMD SG-3 followed by NDMD 16-1(6) and ASG 18-5(6). These findings are in agreement with Panchbhai *et al.*(2006) and Prabhakar *et al.*(2017).

4.2.1.3 Internode length (cm)

Range for length of internode was found 3.43cm to 5 cm. The genotype ASG 18-5 noted minimum length of internode (3.43cm) while, the genotype RMD SG-3 was noted maximum length of internode (5) followed by ASG 18-1 (4.9cm) ASG 16-1 (4.8cm), C.G. Kankoda-2 and RMD 15-2 (4.6cm) respectively. The mean length of internode of twelve genotypes was 4.43cm. The result was corroborate with the result of Bharathi *et al.*, Chhattopdhyay *et at.* (2016), Yadav (2018).

4.2.1.4 Days to first female flower appearance

Range for this trait was 35 to 55 days with a grand average of 44.08 days. Maximum no. of days to first appearance female flower were recorded in ASG 16-1 (55days) followed by ASG 18-2(51days), ASG 18-3(46.66days), ASG 18-1 (46.33days), ASG 18-4 (46.33days) and RMD SG-3(45.66days) whereas, minimum value for this character i.e. 35 days was noted in case of genotypes C.G Kankoda-2, 38 days in NDMD-16, NDMD 16-1 and 39 days in RMD 15-2 respectively. Similar findings are in accordance with Ram *et al.*(2004) and Panchbhai *et al.* (2006).

4.2.1.5 Days to first female flowering node

Range for this trait was 29 to 47 with a grand average of 36.19. C.G Kankoda-2 took minimum no. of days (29 days) for first female flowering node followed by 31 days in each genotype of RMD 15-2, NDMD 16-1 and NDMD 16. Maximum days to first female flowering node were taken by ASG 16-1(47). Similar results have also been noticed by Bharathi *et al.*(2006).

4.2.1.6 Days to first fruit harvest

Range for this character was varied between 59 to 81.66 days. The genotype C.G Kankoda-2 recorded minimum days (59) whereas, the genotype ASG 18-4 recorded maximum first fruit harvest (81.66days) followed by ASG 18-5 and ASG 16-1 (80days) respectively. The mean value for this character was 72.97 days. Earliness is a desirable character hence, C.G Kankoda-2 is a promising genotype in this regards.

Table 4.2: Mean performance for different traits of spine gourd genotypes

Characters Genotypes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ASG 18-1	136.33	7.66	4.9	46.33	36	70.66	131	32.33	72.33	4.3	2.86	6.1	20	12.73	54.1
ASG 18-2	103	7.33	3.9	51	42	78	133	26	69	3.33	2.4	8.76	20.33	15.33	48.96
ASG 18-3	117.3	7	4.46	46.66	42	78.66	118	34.33	61.33	4.2	2.73	8.03	20.66	9.86	51.66
ASG 18-4	106	8.66	4.5	44.33	34	81.66	134	32	64.66	4.16	2.86	8.16	25	11.03	62.33
ASG 18-5	120.66	6	3.43	46	36.33	80	131.66	22.66	65.33	4.23	2.43	8.1	21.33	14.16	52.5
ASG 16-1	118.66	8	4.8	55	47	80	138.33	34.33	68.33	4.3	2.76	6.16	19	8.76	104.56
Indira Kankoda-1 (C)	119	6.33	4.7	44	36	78.33	137.33	24.33	69.33	4	2.8	4.8	21.33	12.06	29.73
RMD SG-3	114	4.66	5	45.66	39	78.33	138.33	33	77	3.5	2.5	7.46	19.33	9.2	67.1
NDMD-16	114	7.66	4.53	38	31	63	120.33	46	62.66	3.96	2.53	5.6	19	8.83	63.33
NDMD 16-1	97.33	6	3.7	38	31	65.33	129.33	36	63.33	4.36	2.76	9	19.33	10.53	46.36
CG Kankoda-2 (C)	123.33	14.33	4.6	35	29	59	121.66	58.66	88.33	4.66	3.16	9.6	16	7.4	157.76
RMD 15-2	118	12	4.6	39	31	64.66	123.66	44.66	78.33	4.33	3.06	6.37	16.66	9.96	84.19

“1 - Vine length (cm), 2 - No. of branches plant⁻¹, 3 -Internode length (cm), 4 - Days to first female flower appearance, 5 - Days to first female flowering node, 6 - Days to first fruit harvest, 7 - Days to last fruit harvest, 8 - No. of fruits plant⁻¹, 9 - Fruiting period, 10 - fruit length(cm), 11 - fruit width(cm), 12 - Average fruit weight(g), 13 - No. of seeds per fruit, 14 - 100 seed weight(g), 15 - fruit yield plant⁻¹ (g)”.

4.2.1.7 Days to last fruit harvest

Range for this trait was vary from 118 to 138.33 with a value of 129.72. Genotype RMD SG-3 and ASG 16-1 took highest no. of days to last fruit harvest (138.33) followed by Indira Kankoda-1 (137.33). Least days to final fruit were reported in case of ASG-3 (118), followed by NDMD 16 (120.33), C.G Kankoda-2 (121.66) and RMD 15-2 (123.66). Similar findings (days to first fruit harvest and days to last fruit harvest) were also observed by Yadav (2018).

4.2.1.8 No. of fruits per plant

Range was varied from 22.66 to 58.66 with a mean value of 35.66. More no. of fruits were recorded in C.G Kankoda-2 (58.66) followed by NDMD 16 (46) and RMD 15-2(44.66). Genotype ASG 18-5 showed less no. of fruits plant⁻¹ (22.66). It showed that long duration taken by fruits in first harvesting reduces the further fruit formation resulting in less no. of fruits plant⁻¹. Wide range for no. of fruits per plant was also reported by Maharana (1995), Ram *et al.* (2004), Bharathi *et al.* (2006), Chattopdhyay *et al.* (2016), Prabhakar *et al.* (2017) and Yadav (2018).

4.2.1.9 Fruiting period

Fruiting period varied from 61.33 to 88.33days with a mean value of 69.52. Long duration of fruiting periods was observed in C.G Kankoda-2 (88.33) followed by RMD 15-2(78.33) and RMD SG-3(77) whereas, shortest fruiting period was recorded in ASG 18-3 (61.33). Variation in fruiting period was also noticed by Naik *et al.* (2012), Basumatary *et al.* (2014). Long fruiting period is advantageous as it increases number of fruit per harvest.

4.2.1.10 Fruit length (cm)

Range for length of the fruit was noticed between 3.33 to 4.66 cm with a overall mean of 4.10. Highest fruit length was measured in C.G Kankoda-2(4.66) followed by NDMD 16-1(4.36), RMD 15-2(4.33), ASG 16-1(4.3) and ASG 18-1(4.3). Lowest fruit length was recorded in ASG 18-2 (3.33). Relevant outcomes were observed by Ram *et al.* (2004), Bharathi *et al.* (2006), Prabhakar *et al.* (2017) but contrary results were noticed by Naik *et al.* (2012) and Yadav (2018).

4.2.1.11 Fruit width (cm)

The average value for width was noticed 2.74cm while the range for width of fruit in the genotypes of spine gourd under study was 2.4 to 3.16cm. Maximum fruit width was observed in C.G Kankoda-2 (3.16) which was followed by RMD 15-2(3.06). ASG 18-2 (2.4cm) had minimum width of fruit of spine gourd. The result was collaborated with the result of Bharathi *et al.* (2006), Panchbhai *et al.* (2006), Rahman *et al.* (2012), Naik *et al.* (2012) and Chattopdhyay *et al.* (2016) but it is contrary to the finding of Yadav (2018).

Maximum fruit length and fruit width was noticed in C.G Kankoda-2 which ultimately leads to increase in fruit yield.

4.2.1.12 Average fruit weight (g)

It was observed that range for this trait was 4.8g to 9.6 g with average value of 7.34 g. Maximum weight of fruit was noticed in C.G Kankoda-2 (9.6g) followed by NDMD 16-1(9.0g). Weight of fruit was recorded minimum in Indira Kankoda-1(4.8g). Hence, C.G Kankoda-2 is found a promising genotype under study.

4.2.1.13 No. of seeds per fruit

Significant difference was observed for no. of seeds per fruit among all genotypes of spine gourd. The mean value was recorded 19.86 while it ranged from 16 to 21.33. Least no. of seeds plant⁻¹ was observed in of C.G Kankoda-2 (16) followed by RMD 15-2(16.66) while, maximum no. of seeds was noted in ASG 18-5(21.33) and Indira Kankoda-1 (21.33). Similar findings (average fruit weight and no. of seeds per fruits) were reported by Prabhakar *et al.*(2017) and Panchbhai *et al.* (2006) respectively.

4.2.1.14 100 seed weight (g)

Among different promising genotypes there was a significant differences for hundred seed weight. It is ranged from 7.4 to 15.33 g with a grand mean of 10.83 g. Minimum value for this trait was observed in C.G Kankoda-2 (7.4g) followed by ASG 16-1(8.76g), NDMD 16 (8.83g), RMD SG-3 (9.2g) and RMD 15-2 (9.96g). Weight of 100 seeds was noted maximum in ASG 18-2(15.33g) followed by ASG 18-5(14.16g), ASG 18-1(12.73g) and Indira Kankoda-1(12.06g). Similar have been also noticed by Naik *et al.* (2007) and Basumatary *et al.*(2014).

4.2.1.15 Fruit yield per plant (g)

Variation was wide i.e. 29.73 to 157.76 g plant⁻¹ for fruit yield. C.G Kankoda-2 had maximum fruit yield per plant (157.76g) while minimum was observed in Indira Kankoda-1 (29.73g). The average value for this trait in the existing genotypes was 68.55 g. Variation for fruit yield was also reported by Ram *et al.* (2004), Bharathi *et al.* (2006), Panchbhai *et al.* (2006), Rahman *et al.* (2011), Basumatary *et al.* (2014), Chattopdhyay *et al.* (2016), Prabhakar *et al.* (2017) and Yadav (2018).

All these characters are directly associated with the yield of the fruit plant⁻¹ for which high mean value is advantageous.

4.2.2 Genotypic and phenotypic coefficients of variation

“Genotypic and phenotypic coefficients of variation are considered as simple measures of variability. These measurements are generally used for variability estimation. The comparative values of these coefficients kinds give an idea of the magnitude of variation in a genetic population. The phenotypic coefficient of variation (PCV) was slightly higher than the corresponding genotypic coefficients of variation (GCV) described the impact of the environment on the expression of the trait under analysis. GCV and PCV are categorized as low (<10%), moderate (10-20%), high (>20%) as suggested by Sivasubhranian and Madhvamenon (1973).” The estimates of GCV, PCV, heritability (bs) and genetic advance as % of mean are described in the Table 4.3.

Among the different yield and its component characters had the highest magnitude of GCV (49.4%) and PCV (49.91%) followed by no. of branches plant⁻¹ (32.72% and 35.98%), no. of fruits plant⁻¹ (28.54% and 29.34%), hundred seed weight (20.99% and 22.89%) and average fruit weight (20.43% and 20.64%). Similar conclusions have also been revealed by Maharana (1995), Ram *et al.* (2004), Panchbhai *et al.* (2006), Chattopdhyay *et al.* (2016), Prabhakar *et al.* (2017) and Yadav (2018) for fruit yield plant⁻¹ and no. of fruits plant⁻¹ in spine gourd. Bharathi *et al.* (2006), Panchbhai *et al.* (2006) and Naik *et al.* (2012) were also in confirmation with the present conclusions.

The moderate GCV and PCV were noticed for days to first female flowering node (15.00% and 15.36%) followed by fruiting period (12.86% and 13.14%), Days to first female flower appearance (12.94% and 13.44%), days to first fruit harvest (10.93% and 12.00%) and length of internode (10.27% and 12.56%). These conclusions were contrary with the findings of Yadav (2018) for days to last fruit harvest, Prabhakar *et al.* (2017) for fruiting period, Panchbhai *et al.* (2006) and Ram *et al.* (2004) for days to female flower anthesis. The remaining all characters showed low GCV and PCV.

4.2.3 Heritability (bs) and genetic advance

“Heritability governs the similarities between parents and their offspring while, the genetic advancement described the information about expected expansion for a specific trait after selection. Heritability suggested the comparative role of genetic factors in expression of phenotypes and also acts as an index of transmissibility of a special character to its progeny. Though, the information of heritability only does not help in formulating tangible breeding programme. Genetic advancement with heritability enables to determine the necessary genetic control for any specific characteristic. The nature and magnitude of a genotypes inherent potential for a trait in a significant parameter measure the magnitude of advancement of any plant species. Heritability and genetic advancement are significant genetic parameters for choosing a genotype that allows higher selection efficiency by separating environmental effect from overall variability.”

Estimates of heritability along with genetic advancement are usually more helpful in determining the character under selection than that of heritability only. However, it is not essential that a trait with a strong heritability also shows a strong genetic advance (Johnson *et al.* 1955). In the present experiment, an opportunity has been created to measure heritability in broad sense and classified as low (<50%), moderate (50-70%) and high (>70%) as suggested by Allard (1999).

The estimates of heritability (bs) and genetic advance as percentage of mean are described in the Table 4.3. Heritability (bs) ranged from 45.37 to 98.04 percent. It was found high for most of the traits under study. The high heritability was observed for average fruit weight (98.04%), fruit yield plant⁻¹ (97.95%),

fruiting period (95.80%), days to first female flowering node (95.35%), days to last fruit harvest (94.68%), no. of fruits plant⁻¹ (94.60%), days to first appearance of female flower (92.68%), hundred seed weight (84.11%), fruit length (83.77%), no. of branches plant⁻¹ (82.72%), days to first fruit harvest (82.17%), length of vine (78.12%) and fruit width (71.97%). The medium and low heritability observed for length of internode (66.94%) and no. of seeds per fruit (45.37%) respectively.

If heritability is inadequate in broad sense, additive and non additive gene effects are coupled with high genetic advance then calculation of heritability would be reliable. The genetic advance of the spine gourd was calculated as a % mean for facilitating the improvement of difficult character in different genotypes.

The magnitude of genetic advance as % mean of was classified as low (<10%), moderate (30-10%) and high (>30%). Genetic advance as a % of mean was noted high for fruit yield plant⁻¹ (97.82%) followed by no. of branches plant⁻¹ (61.32%), no. of fruits plant⁻¹ (57.19%), average fruit weight (41.69%), hundred seed weight (39.67%) and days to first female flowering node (30.18%). Rest of the characters showed medium genetic advance as % of mean.

High heritability coupled with high genetic advance as % of mean was found for fruit yield plant⁻¹, no. of branches plant⁻¹, no. of fruits plant⁻¹, average fruit weight, hundred seed weight and days to first female flowering node which indicates that high percentage of additive gene action in the expression of these characters Hence, these characters should be taken into condition in this crop improvement programme. These outcomes were in line with the present findings of Ram *et al.*(2004), Bharathi *et al.* (2006), Singh *et al.*(2009), Chattopadhyay *et al.*(2016) and Yadav (2018). Medium heritability with medium genetic advance were also reported for rest of the characters except no. of seeds per fruit.

4.3 Correlation coefficient analysis

“The coefficient of correlation is used to assess the strength of the relationship between two factors. In plant breeding, correlation coefficient analysis is used to determine the prevalent correlation between distinct characters and to measure the component characters on which selection can be based for genetic advancement. The choice of efficient breeding method is to facilitate adoption of

information about the correlation between fruit yield and its components. To measure the relationship between two traits, the correlation coefficient at genotypic and phenotypic levels was potentially worked out in all possible combinations between yield components are given in table 4.4 and 4.5.”

In the present experiment the magnitude of genotypic correlation was greater than phenotypic correlations. Minimum phenotypic correlation can be achieved by masking effects and due to revising the effect of the environment on the relationships of the characters. Therefore, significant conclusions based on genotypic relationship of component traits are described here.

Table 4.3: Genetic parameters of variation for fruit yield and its components in spine gourd.

Sl. No.	Characters	Mean	Range		GCV (%)	PCV (%)	H ² (bs) %	Genetic advance	Genetic advance as % of mean
			Minimum	Maximum					
1	Vine length (cm)	115.63	97.33	136.33	8.4	9.50	78.12	17.68	15.29
2	No. of branches plant ⁻¹	7.97	4.66	14.33	32.72	35.98	82.72	4.88	61.32
3	Internode length (cm)	4.43	3.43	5	10.27	12.56	66.94	0.76	17.32
4	Days to first female flower appearance	44.08	35	55	12.94	13.44	92.68	11.31	25.66
5	Days to first female flowering node	36.19	29	47	15.00	15.36	95.35	10.92	30.18
6	Days to first fruit harvest	72.97	59	81.66	10.93	12.00	82.17	14.90	20.42
7	Days to last fruit harvest	129.72	118	138.33	5.48	5.64	94.68	14.27	11.00
8	No. of fruits plant ⁻¹	35.36	22.66	58.66	28.54	29.34	94.60	20.22	57.19
9	Fruiting period	69.52	61.33	88.33	12.86	13.14	95.80	18.04	25.94
10	Fruit length (cm)	4.10	3.33	4.66	9.27	10.13	83.77	0.71	17.48
11	Fruit width (cm)	2.74	2.4	3.16	8.25	9.72	71.97	0.39	14.41
12	Average fruit weight (g)	7.34	4.8	9.6	20.43	20.64	98.04	3.06	41.69
13	No. of seeds per fruit	19.86	16	25	9.81	14.56	45.37	2.70	13.61
14	100 seed weight (g)	10.83	7.40	15.33	20.99	22.89	84.11	4.29	39.67
15	Fruit yield plant ⁻¹ (g)	68.55	29.73	157.76	49.4	49.91	97.95	67.04	97.81

4.3.1 Genotypic correlations of attributing characters with fruit yield per plant.

4.3.1.1 Vine length(cm)

It is indicated significantly positive genotypic correlation with length of internode (0.575), length of fruit (0.413), width of fruit (0.354) and hundred seed weight (0.521). It has significantly negative relationship with mean fruit weight (-0.441). All other characters showed non-significant relationship with this trait.

4.3.1.2 No. of branches per plant

This character had revealed significant and positively correlation with no. of fruits plant⁻¹ (0.831), length of fruit (0.582), width of fruit (0.827), hundred seed weight (0.451) and fruit yield plant⁻¹ (0.825). It indicated significant and negative correlation with days to first appearance of female flower (-0.492), days to first female flowering node (-0.468), days to first fruit harvest (-0.613), days to final fruit harvest (-0.511) and fruiting period (-0.629). Other traits showed non-significant correlations with this trait.

4.3.1.3 Internode length (cm)

This character had significantly positive genotypic relationship with no. of fruits plant⁻¹ (0.337) and fruit width (0.477). However, significantly negative relationship was observed with average fruit weight (-0.562) and no. of seeds per fruit (-0.511). Other traits exhibited non-significant correlations with this trait.

4.3.1.4 Days to first female flower appearance

It had exhibited significantly positive genotypic relationship with days to first female flowering node (0.980), days to first fruit harvest (0.867), fruiting periods (0.655) and days to last fruit harvest (0.611). However, it showed significant negative relationship with no. of fruits plant⁻¹ (-0.704), fruit length (-0.452), fruit width (-0.508) and hundred seed weight (-0.382). Other exhibited non-significant correlation with this character.

4.3.1.5 Days to first female flowering node

This trait described significantly positive correlated with days to first fruit harvest (0.798) and days to last fruit harvest (0.466), fruiting periods (0.500) while, negative and significant correlation with no. of fruits plant⁻¹ (-0.571), fruit length (-

0.448), fruit width (-0.467) and hundred seed weight (-0.468). Other traits exhibited non-significant correlations with this trait.

4.3.1.6 Days to first fruit harvest

It had showed significant and positive relationship with days to last fruit harvest (0.645) and fruiting periods (0.840) and no. of seeds fruit⁻¹ (0.502). However, it indicated significant and negative relationship with no. of fruits plant⁻¹ (-0.859), fruit length (-0.495), fruit width (0.524) and fruit yield plant⁻¹ (-0.469).

4.3.1.7 Days to last fruit harvest

It had recorded significantly positive genotypic relationship with fruiting period (0.906). It showed significantly negative relationship with no. of fruits plant⁻¹ (-0.653), fruit length (-0.403) and fruit width (-0.329). Other traits exhibited non-significant correlations with this trait.

4.3.1.8 No. of fruits per plant

It had showed significantly positive relationship with fruit length (0.511), fruit width (0.682) and fruit yield plant⁻¹ (0.800). However, significantly negative correlation with fruiting period (-0.781) and no. of seeds per fruits (-0.426). Other traits indicated non-significant correlations with this trait.

4.3.1.9 Fruiting period

This character had recorded significantly and positively correlation with no. of seeds per fruit (0.432). It has significant negative relationship with length of fruit (-0.368), width of fruit (-0.395), average fruit weight (-0.378) and fruit yield plant⁻¹ (-0.447). All of the other traits showed non-significant correlations with this trait.

4.3.1.10 Fruit length (cm)

This trait had showed significant and positive relationship with fruit width (0.810) followed by hundred seed weight (0.639) and fruit yield plant⁻¹ (0.494). It exhibited non-significant relationship with all other traits.

4.3.1.11 Fruit width (cm)

It had reported positively and significantly correlation with hundred seed weight (0.473) and fruit yield plant⁻¹ (0.602). All other character indicated non-significant correlations with this trait.

4.3.1.12 Average fruit weight (g)

This character had showed significantly relationship with fruit yield plant⁻¹(0.336) while no. of seeds per fruit, hundred seed weight exhibited non-significantly relationship.

4.3.1.13 No. of seeds per fruit

This character was indicated significantly and positively relation with hundred seed weight (0.450) while non-significant correlation with fruit yield plant⁻¹.

4.3.1.14 100 seed weight (g)

Hundred seed weight observed non-significant correlation with fruit yield plant⁻¹

4.3.1.15 Fruit yield per plant (g)

This trait had exhibited significantly positive relationship with no. of branches plant⁻¹ (0.825) followed by no. of fruits plant⁻¹ (0.800), fruit width (0.602), fruit length (0.494) and average fruit weight (0.336). It had significant negative relationship with fruiting period (-0.447) and days to first fruit harvest (-0.469). Other traits like days to first female flower appearance, days to first female flowering node, length of internode, no. of seeds per fruit, days to last fruit harvest and hundred seed weight demonstrated non-significant correlation.

Table 4.4: Genotypic correlation coefficients for fruit yield and its components in spine gourd

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Vine length (cm)	No. of branches plant ⁻¹	Internode length (cm)	Days to first female flower appearance	Days to first female flowering node	Days to first fruit harvest	Days to last fruit harvest	No. of fruits plant ⁻¹	Fruiting period	fruit length (cm)	fruit width (cm)	Average fruit weight (g)	No. of seeds per fruit	100 seed weight (g)	fruit yield plant ⁻¹ (g)
1	-														
2	0.290	-													
3	0.575**	0.212	-												
4	0.073	-0.492**	0.081	-											
5	0.028	-0.468**	0.122	0.980**	-										
6	-0.074	-0.613**	-0.006	0.867**	0.798**	-									
7	-0.100	-0.511**	0.133	0.611**	0.466**	0.645**	-								
8	0.131	0.831**	0.337*	-0.704**	-0.571**	-0.859**	-0.653**	-							
9	0.007	-0.629**	0.148	0.655**	0.500**	0.840**	0.906**	-0.781**	-						
10	0.413*	0.582**	-0.001	-0.452**	-0.448**	-0.495**	-0.403*	0.511**	-0.368*	-					
11	0.354*	0.827**	0.447**	-0.508**	-0.467**	-0.524**	-0.329*	0.682**	-0.395*	0.810**	-				
12	-0.441**	0.213	-0.562**	-0.180	-0.132	-0.125	-0.216	0.196	-0.378*	0.068	0.017	-			
13	-0.140	-0.070	-0.511**	0.190	-0.014	0.502**	0.129	-0.426**	0.432**	0.140	0.046	0.207	-		
14	0.521**	0.451**	-0.309	-0.382*	-0.468**	-0.249	-0.183	0.159	-0.165	0.639**	0.473**	0.269	0.450**	-	
15	0.279	0.825**	0.309	-0.276	-0.189	-0.469**	-0.262	0.800**	-0.447**	0.494**	0.602**	0.336*	-0.288	0.296	-

* Significant at 5% level

** Significant at 1% level



Plate 4.1(a): Plant of different genotypes of spine gourd

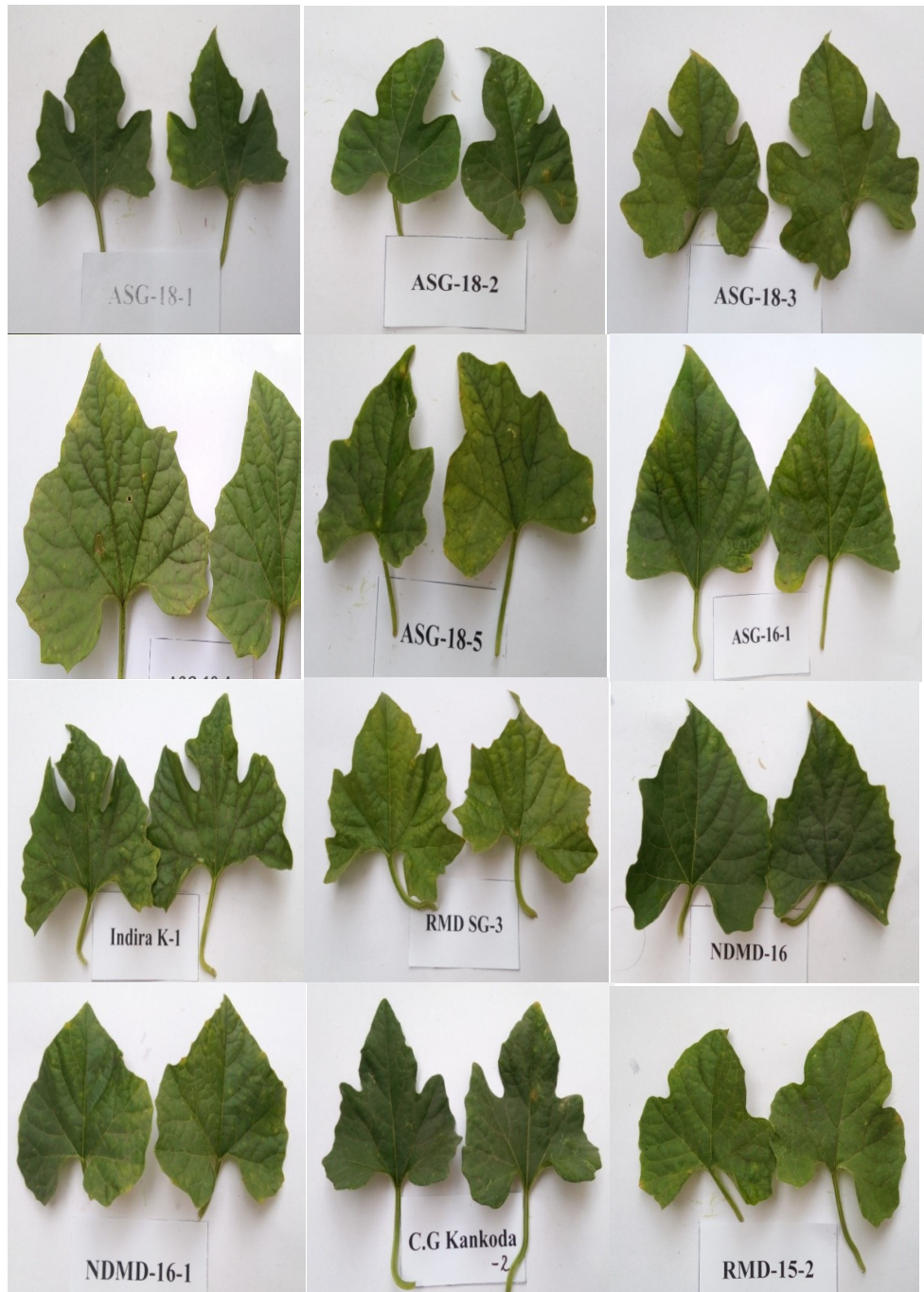


Plate 4.2(b): Variability in spine gourd genotypes (leaf shape and size)



Plate 4.3(c): Variability in spine gourd genotypes (fruit shape and size)



Plate 4.4(d): Variability in spine gourd genotypes (seed size, seed shape and seed colour)

4.3.2 Phenotypic correlations of attributing characters with fruit yield per plant

4.3.2.1 Vine length (cm)

Length of vine exhibited significant and positive phenotypic relationship with length of internode (0.368), length of fruit (0.333) and hundred seed weight (0.332). While, significantly negative correlation with a mean fruit weight (-0.396). The rest of the traits indicated non-significant correlations with this trait.

4.3.2.2 No. of branches per plant

It had significantly positive phenotypic correlations with fruit yield plant⁻¹ (0.754), fruit width (0.725), fruit length (0.491) and hundred seed weight (0.410) while, significantly negative relationship with days to first appearance of female flower (-0.429), days to female flowering node (-0.444), days to first fruit harvest (-0.528), days to last fruit harvest (-0.455) and fruiting period (-0.549). Other traits exhibited non-significant correlations with this trait.

4.3.2.3 Internode length (cm)

Length of Internode exhibited significantly negative phenotypic relationship with average fruit weight (-0.484). The rest of the characters showed non-significant correlations with internode length.

4.3.2.4 Days to first female flower appearance

This character had indicated significantly positive phenotypic relationship with days to first female flowering node (0.904), days to first fruit harvest (0.752) days to last fruit harvest (0.556) and fruiting period (0.621). It indicated significantly negative relationship with no. of fruits plant⁻¹ (-0.639), length of fruit (-0.412) and fruit width (-0.409).

4.3.2.5 Days to first female flowering node

This character had noticed significant and positive phenotypic relationship with days to first fruit harvest (0.705), days to last fruit harvest (0.439) and fruiting period (0.480). It also exhibited negative significant relationship with no. of fruits plant⁻¹ (-0.543), fruit length (-0.391), fruit width (-0.438) and hundred seed weight (-0.410). Other traits exhibited non-significant correlations with this trait.

4.3.2.6 Days to first fruit harvest

This trait was exhibited significantly positive relationship with days to last fruit harvest (0.579). However, it showed non-significant and negative relationship with no. of fruits plant⁻¹ (-0.749), length of fruit (-0.383), width of fruit (-0.441) and fruit yield plant⁻¹ (-0.428). Other traits exhibited non-significant correlations with this trait.

4.3.2.7 Days to last fruit harvest

This trait was indicated significantly positive relationship between with fruiting period (0.838) while, significantly negative relationship with no. of fruit traits plant⁻¹ (-0.628) and fruit length (-0.379).

4.3.2.8 No. of fruits per plant

It had significantly positive relationship with fruit length (0.476), fruit width (0.545) and fruit yield plant⁻¹ (0.779). While, it showed significant and negative relation with fruiting period (-0.735). All other characters showed non-significant correlations with this trait.

4.3.2.9 Fruiting period

This character indicated significant and negative phenotypic relations with fruit width (-0.365), average fruit weight (-0.376) and fruit yield plant⁻¹ (-0.433). All other characters showed non-significant correlations with this trait.

4.3.2.10 Fruit length (cm)

It had exhibited significantly positive phenotypic relationship with width of fruit (0.667), hundred seed weight (0.552) and fruit yield plant⁻¹ (0.461).

4.3.2.11 Fruit width (cm)

It had indicated significantly positively relationship with hundred seed weight (0.362) and fruit yield plant⁻¹ (0.535).

4.3.2.12 Average fruit weight (g)

This character was indicated significantly positive correlation with fruit yield plant⁻¹ (0.365).

4.3.2.13 No. of seeds per fruit

This character was indicated significantly positive correlated with hundred seed weight (0.396).

4.3.2.14 100 seed weight (g)

It had showed non-significant relationship with fruit yield plant⁻¹.

4.3.2.15 Fruit yield per plant (g)

This character indicated significantly and positively phenotypic relationship with no. of branches plant⁻¹ (0.754), no. of fruits plant⁻¹ (0.779), length of fruit (0.461), width of fruit (0.535) and average fruit weight (0.365). It also exhibited significantly negative relationship with days to first fruit harvest (-0.428) and fruiting period (-0.433) and fruiting period (-0.433), while non-significant association with rest of the characters was observed.

Table 4.5 Phenotypic correlation coefficients for fruit yield and its components in spine gourd.

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Vine length (cm)	No. of branches plant ⁻¹	Internode length (cm)	Days to first female flower appearance	Days to first female flowering node	Days to first fruit harvest	Days to last fruit harvest	No. of fruits plant ⁻¹	Fruiting period	fruit length (cm)	fruit width (cm)	Average fruit weight (g)	No. of seeds per fruit	100 seed weight (g)	fruit yield plant ⁻¹ (g)
1	-														
2	0.214	-													
3	0.368*	0.194	-												
4	0.044	-0.429**	0.030	-											
5	0.031	-0.444**	0.108	0.904**	-										
6	-0.034	-0.528**	-0.015	0.752**	0.705**	-									
7	-0.107	-0.455**	0.064	0.556**	0.439**	0.579**	-								
8	0.153	0.707**	0.267	-0.639**	-0.543**	-0.749**	-0.628**	-							
9	0.025	-0.549**	0.123	0.621**	0.480**	0.749**	0.838**	-0.735**	-						
10	0.333*	0.491**	0.070	-0.412*	-0.391*	-0.383*	-0.379*	0.476**	-0.322	-					
11	0.282	0.725**	0.316	-0.409*	-0.438**	-0.441**	-0.267	0.545**	-0.365*	0.667**	-				
12	-0.396*	0.202	-0.484**	-0.172	-0.128	-0.122	-0.200	0.185	-0.376*	0.055	0.014	-			
13	-0.118	-0.011	-0.049	0.081	0.037	0.304	0.048	-0.274	0.278	0.135	-0.024	0.127	-		
14	0.332*	0.410*	-0.185	-0.315	-0.410*	-0.229	-0.178	0.129	-0.142	0.552**	0.362**	0.254	0.396*	-	
15	0.250	0.754**	0.255	-0.245	-0.186	-0.428**	-0.254	0.779**	-0.433**	0.461**	0.535**	0.365*	-0.205	0.275	-

** Significant at 1% level

* Significant at 5% level

The fruit yield plant^{-1} revealed significantly positive relationship with no. of branches plant^{-1} , no. of fruits plant^{-1} , length of fruit, width of fruit and average fruit weight at both phenotypic and genotypic levels.

Analogous findings on relationship of fruit yield plant^{-1} with no. of fruits plant^{-1} has been also noticed by Aliya *et al.* (2014), Basumatary *et al.* (2014) and Chattopadhyay *et al.* (2016), with length of fruit along with fruit width by Rahman *et al.* (2011), Aliya *et al.* (2014), Archana *et al.* (2017) and Prabhakar *et al.* (2017), with average fruit weight by Rahman *et al.* (2011), Aliya *et al.* (2014) and Prabhakar *et al.* (2017) in spine gourd genotypes.

The character fruit yield plant^{-1} had significant negative relationship with days to first fruit harvest and fruiting period at both phenotypic and genotypic levels. It showed that long duration taken by fruits in first harvesting reduces the further fruit formation resulting in less no. of fruits plant^{-1} . Similar outcomes were observed by Prabhakar *et al.* (2017) in spine gourd.

Significantly positive relationship was recorded among fruit yield and its component characters. Increase in no. of branches, fruit length, fruit width and average fruit weight resulted in raise in overall fruit weight which finally increases the total fruit yield plant^{-1} in spine gourd. Therefore, direct selection for these traits would be helpful for enhancement in fruit yield.

Table 4.6: Summary of significance of genotypic and phenotypic correlation for fruit yield and its components in spine gourd;

S.No.	Characters		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Vine length(cm)	G	-														
		P															
2	No. of branches plant ⁻¹	G		-													
		P															
3	Internode length (cm)	G	(+)		-												
		P	(+)														
4	Days to first female flower appearance	G		(-)		-											
		P		(-)													
5	Days to first female flowering node	G		(-)		(+)	-										
		P		(-)		(+)											
6	Days to first fruit harvest	G		(-)		(+)	(+)	-									
		P		(-)		(+)	(+)										
7	Days to last fruit harvest	G		(-)		(+)	(+)	(+)	-								
		P		(-)		(+)	(+)	(+)									
8	No. of fruits plant ⁻¹	G		(+)	(+)	(-)	(-)	(-)	(-)	-							
		P		(+)		(-)	(-)	(-)	(-)								
9	Fruiting period	G		(-)		(+)	(+)	(+)	(+)	(-)	-						
		P		(-)		(+)	(+)	(+)	(+)	(-)							
10	fruit length (cm)	G	(+)	(+)		(-)	(-)	(-)	(-)	(+)	(-)	-					
		P	(+)	(+)		(-)	(-)	(-)	(-)	(+)							
11	fruit width (cm)	G	(+)	(+)	(+)	(-)	(-)	(-)	(-)	(+)	(-)	(+)	-				
		P		(+)		(-)	(-)	(-)		(+)	(-)	(+)					
12	Average fruit weight (g)	G	(-)		(-)						(-)			-			
		P	(-)		(-)						(-)						
13	No. of seeds per fruit	G			(-)			(+)		(-)	(+)					-	
		P															
14	100 seed weight (g)	G	(+)	(+)		(-)	(-)					(+)	(+)		(+)	-	
		P	(+)	(+)			(-)					(+)	(+)		(+)		
15	fruit yield plant ⁻¹ (g)	G		(+)				(-)		(+)	(-)	(+)	(+)	(+)			-
		P		(+)				(-)		(+)	(-)	(+)	(+)	(+)			

CHAPTER-V SUMMARY AND CONCLUSIONS

The present investigation entitled “Study on genetic variability for yield and its components in spine gourd (*Momordica dioica* Roxb.)” was carried out at Horticulture farm, College of Agriculture, IGKV, Raipur in *kharif* season 2018. The experiment was conducted in “Randomized Block Design” with 12 promising genotypes that include two checks in 3 replications to estimate the heritability, genetic advance, variability and the correlation coefficient.

Observations are recorded for visual trait and for metric trait on randomly selected five plants. Visual trait includes “days to first fruit harvest, days to first female flower appearance, days to first female flowering node, days to last harvest fruit and fruiting period” were observed while, metric trait includes “length of the vine (cm), internode length (cm), no. of branch per plant, no. of fruits per plant, fruit width (cm), length of the fruit (cm), average weight of the fruit (g), no. of seed per fruit, weight of 100 seed (g), and yield of fruit per plant (g)”.

The variance analysis revealed that the difference is highly significant among twelve promising genotypes of spine gourd for all the fifteen characters. It also revealed that the existence of a considerable variability for various traits which can be utilized for improvement in the spine gourd.

Maximum vine length was recorded in ASG 18-1 followed by C.G. Konkoda-2, whereas minimum in NDMD 16-1. No. of branch per plant was noticed maximum in C.G. Konkoda-2 while, minimum in RMD SG-3. With respect to internode length, genotype RMD SG-3 was found maximum and genotype ASG 18-5 was minimum in length. Minimum days to first female flower appearance was noted in C.G. Konkoda-2, whereas maximum in ASG 16-1. C.G. Konkoda-2 took least number of days for first female flowering node. C.G. Konkoda-2 produced first fruits with minimum days to harvest. Maximum no. of days to last harvest of fruit was noticed in RMD SG-3 and ASG 16-1 followed by NDMD 16-1 and C.G. Konkoda-2. Maximum fruits per plant was exhibited in C.G. Konkoda-2. Longest fruiting period was observed in C.G. Konkoda-2. Maximum

fruit length was measured in C. G. Konkoda-2. Maximum width of fruits was observed in C. G. Konkoda-2. Maximum fruit weight was observed in C. G. Konkoda-2 followed by NDMD 16-1. Less number of seeds was noticed in C.G. Konkoda-2. Minimum weight of 100 seeds was formed in C.G. Konkoda- 2 followed by ASG 16-1 and NDMD 16. Highest fruit yield was observed in C.G. Konkoda-2 followed by ASG 16-1 and RMD 15-2. Based on the mean performance, growth of the plant, earliness and fruit yield attributing traits, the genotypes C.G. Konkoda-2, RMD 15-2, RMD SG-3, ASG 16-1 and ASG 18-1 were found not only high yielder but also with other desirable characters.

Among the different attributing traits including yield of fruit per plant had the highest GCV and PCV followed by no. of stems per plant, no. of fruit per plant, average fresh weight and weight of 100 seed. Moderate GCV and PCV were noticed for days for the first female flowering node, internode length, days to first female flower appearance, days for the first harvest fruit and fruiting period and rest of the characters exhibited low GCV and PCV. It provides the considerable scope for yield improvement in the present genotypes of spine gourd. However, fruit per yield plant, 100 seed weight and average weight of the fruit has considerable genetic variability which can be utilized for the yield improvement.

High heritability combined with high genetic advance were reported for “fruit yield per plant, no. of branch per plant, no. of fruits per plant, average fruit weight, 100 seed weight and days for the first female flowering node” which demonstrated that predominance nature of additive gene in the expression of these characters which could be used for improvement of these yield attributing characters throughout selection in breeding programme. Medium heritability combined with medium genetic advance was also reported in rest of the characters indicated non-additive action of genes.

The genotypic and phenotypic correlation coefficient for all characters revealed that “vine length had a significantly positive association with internode length, fruit length, fruit width and 100 seeds weight and had a negative and significant association with the average weight of the fruit. The no. of branch per plant was found significantly and positively correlated with no. of fruits per plant, fruit width, 100 seeds weight, fruit length and fruit yield per plant and had a

significantly negative correlation with days to first female flower appearance, days to first fruit harvest, days to first female flowering node, days to last fruit harvest and the fruiting period”.

The days to first female flower appearance was found significantly positive relationship with “days to first node of female flower, days to last fruit harvest, days to first fruit harvest and fruiting period” and had a significantly negative correlation with “no. of fruits per plant, length and width of the fruit”. The days to first female flowering node had a positive significant relationship with “fruiting period, days to first fruit harvest and days to last fruit harvest”, but they had a significantly negative correlation with “no. of fruit per plant, length of the fruit, width of the fruit and weight of 100 seeds”.

The days to first fruit harvest was found significantly and positively correlated with “days to last fruit harvest and fruiting periods”, but they had a significantly negative correlation with “no. of fruits per plant, fruit length, fruit width and fruit yield per plant”. No. of fruits per plant significantly positive association with “fruit length, fruit width and fruit yield per plant” and had a significantly negative correlation with fruiting periods.

The fruiting period had a significantly positive association with the no. of seeds per fruit at the genotype level and had a negative significant relationship with “fruit width, fruit average weight and fruit yield per plant”. The average fruit weight had a positive significant relationship with the yield of the fruit per plant. The no. of seeds per fruit had a significant positive relationship with weight of 100 seeds.

The yield fruit per plant was found significant positive relationship with “no. of branches per plant, no. of fruits per plant, fruit length, fruit width and average fruit weight”, but had a significant negative relationship with the “days to first fruit harvest and fruiting periods” in both genotypic and phenotypic levels.

Conclusions

1. Based on the variance analysis, it revealed the existence of a considerable amount of genetic variability for yield and its component characteristics which can be exploited through selection for the genetic improvement of spine gourd.

2. C.G. Konkoda-2 (157.76g) produced highest fruit yield followed by RMD 15-2 (84.19g) and ASG 18-2 (48.96g).
3. C.G. Konkoda-2 (16) was found to be early since, it required less days for appearance of female flower (35) as well as no. of days to first fruit harvest (59).
4. Longest fruiting period was observed in C. G. Konkoda-2 (88.33) followed by RMD 15-2 (78.33) whereas it was shortest in ASG 18-3 (61.33).
5. Less no. of seeds was noted in C. G. Konkoda-2 (16) while more no. of seeds in ASG 18-4 (25).
6. The high heritability coupled with a high genetic advance was observed for the yield of fruit per plant (97.95%, 97.81%), no. of branch per plant (82.72%, 61.32%), no. of fruit per plant (94.60%, 57.19%), average weight of the fruit (98.04%, 41.69%), days until the first female flowering node (95.35%, 30.18%) and 100 seeds of weight (84.11%, 39.67%) that could be used for genetic improvement in the spine gourd.
7. Correlation studies have revealed that fruit yield is significantly and positively associated with the no. of branch per plant (0.754, 0.825), no. of fruits per plant (0.779, 0.800), width of the fruit (0.535, 0.602), length of the fruit (0.461, 0.494) and average weight of the fruit (0.365, 0.336) at both phenotypic and genotypic levels. Thus selection of characters will be useful in the improvement programme.

REFERENCES

- Aliya, F., Begum, H., Reddy, M.T., Sivaraj, N., Pandravada, S.R. and Narshimulu, G. 2014. Correlation and path coefficient analysis of quantitative characters in spine gourd (*Momordica dioica* Roxb.) Pak. J. Bio. Sci., 17(5):659-666.
- Allard, R.W. 1999. Principles of Plant Breeding. 2nd Edn., John Willey and Sons, New York, USA, Pages:254.
- Archana, K.A., Prasanna, K.P. and George, T.E. 2017. Evaluation of spine gourd genotypes for variability. Journal of tropical agriculture, 54(1):159-163.
- Baratakke, R., Patil, C., Poornima, B. and Sankannavar, S.H. 2013. Molecular tool for sex identification (female) in *Momordica dioica* Roxb with reference to medicinal values. International Journal of Ayurveda and Pharma Research, 4(4):487-490.
- Basumatary, P., Bora, C.G., Kalita, U.C., Saikia, L. and Deka, N.C. 2014. Variability and correlation studies in spine gourd (*Momordica dioica* Roxb.). Direct Research Journal of Agriculture and food science, 2(7):77-81.
- Bharathi, L.K., Naik, G. and Dora, D.K. 2006. Studies on genetic variability in spine gourd. Indian J. Hort., 63 (1): 96-97.
- Burton, G.W. and Devane, E.H. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. Agron. J., 45:478-481
- Chattopadhyay, A., Rana, N.P., Seth, T., Das, S. and Dutta, S. 2016. Character association and genetic divergence in teasel gourd (*Momordica subangulata* subsp. *renigera*). Veg. Sci., 43(2):289-292.
- Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic environmental variability in soybean. Agron. J., 47:314-318.
- Lush, J.L. 1949. Heritability of quantitative characters in farm animals. Heredity Lond Supply. 35(1):356-387.

- Maharana, U.K., Tripathi, P. and Maharana, T. 1995. Genetic variability and heritability studies in spine gourd. *Curr. Res.*, 24(7):122-124.
- Naik, A., Akhtar, S. and Chattopadhyay, A. 2012a. Study of genetic variability, heritability and genetic advance for fruit quality characters in teasel gourd (*Momordica subangulata blume. Subsp. renigera*). *Afr. J. Agric. Res.*, 7(49):6550-6552.
- Naik, A., Akhtar, S., Thapa, U. and Hazra, P. 2012b. Genetic variability, heritability and genetic advance in teasel gourd (*Momordica subangulata blume. Subsp. renigera*). *Environment and ecology*, 30(3B): 865-867.
- Panchbhai, D.M., Muthukumar, Deshmukh, D.T. and Kale, V.S. 2006. Variability studies in spine gourd (*Momordica dioica* Roxb.). *Advances in plant science*, 19(1):267-270.
- Prabhakar, V. and Kushwah, S.S. 2017. Path coefficient analysis for yield and yield attributing traits in spine gourd (*Momordica dioica* Roxb.). *Journal of pharmacognosy and phytochemistry*, 6(2):139-141.
- Prabhakar, V. and Kushwah, S.S. 2017. Variability analysis in spine gourd (*Momordica dioica* Roxb. ex Wild): An Underutilized Nutritive Vegetable. *Int. J. Pure and applied Bioscience*, 5(4): 1440-1443.
- Puzari, N.N. (1999). Correlation between fresh weight of fruit and seed content of spine gourd (*Momordica cochichinensis* Roxb.). *Indian J. Hill Farming*, 12(2): 117-118.
- Rahman, M., Chakraborty, L. and Acharyya, P. 2011. Studies on genetic variability and divergence in sweet gourd (*Momordica subangulata* ssp. *renigera* [(G. Don) W.J. de Wilde) accessions collected from West Bengal. *Indian J. Pl. Genet. Resour.*, 24 (1): 67-73.
- Rai, G.K., Singh, M., Rai, N.P., Bhardwaj, D. R. and Kumar, S. 2012. In vitro propagation of spine gourd (*Momordica dioica* Roxb.) and assessment of genetic fidelity of micropropagated plants using RAPD analysis. *Physiol. Mol. Biol. Pl.*, 18(3):73-80.

- Ram, D., Kumar, S., Verma, A. and Rai, M. 2004. Variability analysis of underutilized nutritive vegetable kartoli: Indian Collection. Cucurbits Genetics Cooperative Report, 27:66-68.
- Rashid, M. M. 1976. Vegetable in Bangladesh (In Bengali). 1st Edition Bangla Academy, Dhaka Bangladesh, pp.494.
- Rasul, M.G. 2003. Study on parthenocarpy and genetics diverdence in kakrol (*Momordica dioica* Roxb.). Ph.D.Thesis, Kyushu University. Fukuoka, Japan.
- Rasul, M.G., Hiramatsu, M. and Okubo, H. 2004.Morphological and physiological variation in kakrol (*Momordica dioica* Roxb.) J. Fac. Agric. Kyushu Univ., 49(1):1-11.
- Searle,S.R.1961.Phenotypic,genetic and environmental correlations Biometrics,17: 474-480.
- Singh, D., Bahadur V., Singh D.B. and Ghosh, G. 2009. Spine gourd (*Momordica dioica*):An underutilized vegetable with high nutritional and medicinal values. Acta.Hortic., 809:241-249.
- Singh, R.K. and Chaudhary, B.D. 1985. Biometrical methods in quantitative genetics.Kalyani publishers, Ludhiana, 40:163.
- Sivasubramanian, S. and Menon, M. 1973.Heterosis and inbreeding depression in rice.Madras Agric. J., 60:1139.
- Yadav, R.K. 2018.Study of genetic variability, heritability and genetic advance for yield and its components in spine gourd (*Momordica dioica* Roxb.) Int. J. Chemi. Std., 6(6):681-682.
- Yadav, R.K. 2018.Performance of kheksi (*Momordica dioica* Roxb.) genotypes in Northern Hill Zone of Chhattisgarh. Int. J. Chemi. Stud., 6(6):2819-2820.

Appendix-A: Meteorological parameters recorded during the period of investigation

Standard Weeks	Average weekly Temperature (⁰ C)		Average weekly Rainfall (mm)	Relative Humidity (%)		WS (kmph)	SS (hr.)
	Max.	Min.		Max.	Min.		
1 April – 7 April	38.6	22	1.9	66.7	23	5.1	7.9
8 April – 14 April	37	23.7	1.5	66.1	26.5	4.3	7.2
15 April – 21 April	39.6	23.7	2.4	69	23.5	4.4	9.8
22 April – 28 April	41	21	0	45.2	20.7	4.3	9.7
29 April – 5 May	41	26.1	0.4	61.1	24.4	6.9	9.7
6 May – 12 May	42.9	28.7	0	46	19.4	6.5	9.5
13 May – 19 May	40.4	25	1.7	69	35.1	6.1	8.0
20 May – 26 May	42.0	29.1	0	63.2	36.7	7.0	8.5
27 May – 2 June	41.1	28.1	0.4	70.7	39	6.9	7.3
3 June – 9 June	37.9	26.9	1.9	76.7	42.5	5.6	6.4
10 June – 16 June	36.9	25.8	11.6	80	42.4	7.6	6.1
17 June – 23 June	38.5	26.6	3.7	73.4	41.2	6.5	8.9
24 June – 30 June	33.6	26.1	2.4	83.5	59.2	6.9	4.8
1 July – 7 July	35.6	25.7	1.6	86.1	57	8	4.2
8 July – 14 July	31.4	25	46.4	93.4	81.5	6.1	5.1
15 July – 21 July	30.8	25.4	12.6	91.5	82.1	7.4	0.8
22 July – 28 July	29	24.8	16.2	89.7	81.2	9.0	1.4
29 July – 4 Aug	31.6	25.3	31.0	88.2	63.4	6.2	1.2
5 Aug – 11 Aug	30.3	24.8	22.1	91.8	83	6.2	16.1
12 Aug – 18 Aug	30	25.1	27.2	92.8	82	4.1	3.5
19 Aug – 25 Aug	29.5	24.9	8.3	93.2	79.1	5.1	3.6
26 Aug – 1 Sep	28.9	24.9	41.5	95.8	84.4	6.6	0.8
2 Sep – 8 Sep	28.8	23.7	6.2	91.7	77.1	7.4	3.8
9 Sep – 15 Sep	32.2	24.9	0	90.8	55.5	2.4	6.3
16 Sep – 22 Sep	31.6	24.5	11.1	91.2	66.5	3.5	5.3
23 Sep – 29 Sep	32.1	24.7	11	93.1	61.5	1.2	6.5
30 Sep – 6 Oct	34.1	24.1	0	91	45.1	1.02	8.2
7 Oct – 13 Oct	32.7	22.7	0	87	50.4	2.6	6.9
14 Oct – 20 Oct	32.9	21.2	0	90	39.4	1.2	8.4
21 Oct – 27 Oct	33.4	19.8	0	85.7	49.4	0.9	8.2
28 Oct – 3 Nov	30.7	19.0	0	85	43	2.6	9.2
4 Nov – 10 Nov	32.5	18.6	0	85	36.8	1.1	8.4
11 Nov – 17 Nov	31.4	14.1	0	86.2	27.8	0.8	9
18 Nov – 24 Nov	31.7	15.7	0	87.2	30	1	8
25 Nov – 1 Dec	29.3	13.2	0	89.4	33.1	1	7.4
2 Dec – 8 Dec	28.3	12.5	0	87.2	37.5	0.9	4.3
9 Dec – 15 Dec	27.6	15.7	0	85.8	50.7	0.9	1.1
16 Dec – 22 Dec	22.4	11.9	6.7	89.5	56.8	3	4.4
23 Dec – 29 Dec	25.5	9.3	0	86.4	29.2	1.9	7.5

VITA

Name : Sukwariya Devi
Date of birth : 15 February 1995
Present : Sai Colony, krishaknagarjora, Raipur (C.G.)
Address : Pine code – 492012
Phone : 7509196701
Email : sukwariyarani0395@gmail.com
Permanent : M/309 koriya line, BartungaPost –Chirimiri, Dist. –
Address : Koriya(C.G.) Pine code – 497449

Academic Qualification:

Degree	Year	University/Institute
B.Sc.	2017	IGKV, Raipur (C.G.)
HSE	2012	CGBSE, Raipur (C.G.)

Professional Experience (If any): RAWEP

Membership of Professional Societies (If any): NO

Award / Recognition (If any): NO

Publications (If any): 0


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