Evaluation of French Bean (*Phaseolus Vulgaris* L.) Genotypes for Growth, Yield and Seed Production at Khumaltar

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Abstract:
The experiment was conducted at the end of July in NHRC**,** Khumaltar (1332 masl) located at Longitude 27.6485º N and Latitude 85.3253º E situated at Province no. 3, Lalitpur, Nepal in 2077/04/18 to 2077/04/28. The experiment was carried out in Randomised Complete Block Design (RCBD) with four treatments and five replications. The genotypes Trishuli, Chaumase, Semi Light Long and Semi Long Green Bean were used as treatment. Phenotypic traits like Plant Height, Days to maturity, Number of node at harvest in main stem, Flower colour, No of pod per plant at harvest, Dry pod colour, Single pod weight at harvest, pod length, Seed yield per plant, Seed weight per pod, 1000 seed weight, Moisture %, Seed weight per plant(gm), seed weight per pod after drying per plant (gm), seed weight after drying were taken. Plant height was highest in Semi long ligh which is 332 cmt and lowest in Trishuli which is 294.48 cm. Total number of seed was found highest in Semi Long Green 8.6 and least in Trishuli 7. The highest yield was found in Trishuli 2.69 ton/ha followed by Chaumase 2.56 ton/ha, Semi long green 2.33 ton/ha, and the lowest was seen in Semi Long Light 1.51 ton/ha.

Keywords: Genotypes, Phenotypic, Semi Long Green, Maturity, French Bean, Yield.

1.0. Introduction

French bean (Phaseolus vulgaris L.) is a native crop of central and South America Pole beans are mainly cultivated as green vegetables in Nepal [1]. They can be cultivated in various growing seasons and are widely grown in the temperate, sub-tropical, and tropical regions. The crop is cultivated in a wide range of agro-climatic conditions from terai (300 masl) to high hills (2500masl). However, the crop grown is often grown in association with maize. It is more important in the hills of Midwestern Nepal and other areas with similar agro-climatic condition [2]. It is a major vegetable crop in Nepal and most of the tropical Asia where indigenous pulses are preferred. The optimum mean temperature for French bean is 20-25º C for its growth and better productivity [3]. French bean is one of the important leguminous crops which achieve its foremost importance in cultivation in the agricultural field due to its higher nutritional index of protein in fresh pods (1.7%) as well as in dried seeds (21.1%) that serve as a cheap source of higher protein [4]. The consumption of dry common beans (Phaseolus vulgaris) has been associated with a decrease risk for a wide variety of chronic and degenerative diseases such as cancer, obesity, diabetes and cardiovascular diseases [5]. French beans are a good source of dietary fiber, low in calories, and contain Vitamins A, B, and C as well as folates, minerals (iron, calcium, potassium, and selenium), and antioxidants such as lutein and beta-carotene [4]. The major cropping patterns involving beans are: bean-wheat, bean- barley and bean-other vegetables, maize + bean - wheat or barley. It is also grown as an intercrop in the interspaces of apple orchards [2].

There is an enormous export potential, as beans that is produced in the hills have better taste and get higher market price than those from the plain area. Green pods are rich in vitamins, protein and minerals. Moreover, a huge amount of French bean is consumed as soup [6]. The average national productivity of French bean is very small due to the inaccessibility of high yielding improved varieties and package of cultivation practices. Its dry seed contains 21.1 per cent protein, 69.9 per cent carbohydrates, 1.7 per cent fat, 381 mg calcium, 425 mg phosphorous and 12.4 mg iron per 100 g of edible part [7]. French bean is a warm season vegetable that cannot stand frost. French bean is one of the important economic legume crops as it offers direct economic returns in the form of green pod that are directly used as fresh vegetable, dried seed as pulse purpose while the foliage is used as fodder for animals and also add nitrogen to the soil. It is also the rich source of food for nitrogen fixing bacteria in the soil , The deep root system helps in bringing up the food nutrients from the lower region [8]. The optimum sowing time of bean varies in accordance with growing season, types of varieties, location etc. it is grown as a winter crop in terai and inner terai. It is mainly grown as a rainy season crop in hills. Generally, beans are viewed as 'meat of the poor' that gives essential protein to the undernourished people living in hills [9]. Among the micronutrients deficiency boron is found to affect plant growth and decrease yields which is one of the major constraints that limits the production of pulse crops [10,11]. Selection of particular variety for seed production is also prime important for higher seed yield. Hence, it is essential to look forward for the production of quality seed in the state itself to uplift quality production of French bean [12]. Therefore, the present research was undertaken with the objectives to evaluate the performance of French bean varieties for seed yield and its varietal characterization based on plant morphology.

1.1. Origin and distribution

French bean (Phaseolus vulgaris L.), a native crop of central and South America and is one of the oldest cultivated plants in the world [1, 13]. Its cultivation was started 7000 years ago by the Indian tribes in Mexico and Peru [3]. Beans are also of importance in North America and Europe. Then from Europe, it spread to the U.S.A., the West Indies, India and other many parts of the world [8]. Due to its ability of adaptability, it can be cultivated from tropical to temperate regions [13]. In case of temperate countries, varieties are developed for fresh pod consumption and for processing as frozen vegetables [8]. Both pole and bush types of French beans are famous in Nepal. However, In Nepal pole bean is the most important and predominantly cultivated one as green vegetable and for seed production. It is mainly cultivated from 300 m to 2,500 m in different growing season [2]. The crop is mostly grown in association with maize is more important in the hills of mid-western Nepal and other areas with similar agro-climatic condition. In Jumla and adjoining area, farmers usually grow beans during summer season in uplands as a rainfed crop [2]. It is mostly cultivated in the temperate, sub-tropical and tropical regions and it is one of the most important legumes grown world- wide for human consumption [3].

1.2. Statement of problem

Nepal is a developing country where agriculture is the major profession of about 65.6% of total population. Subsistence farming system is predominant in Nepal due to the fragment land holding and small land holding of Nepalese farmer. The contribution of agriculture in national GDP of Nepal is 27.08. Traditional farming, lack of proper irrigation system, lack of transport and market, lack of improved seed, unscientific and undemocratic distribution of land, lack of technical manpower, poor economic condition of farmer, lack of research activities are major problem of seed production in french bean. In Nepal, only one variety of pole type bean named Trishuli has been registered in 1994 and even today, farmers do not have choices for pole bean varieties with higher yield potentiality and preferred characters [3]. Moreover, in past decades, the area and production of seed of French bean is increasing but

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production is not sufficient to meet the demand of the country because of the lack of seed quality (potential germination, genetic quality, mechanical purity, seed pathogen and pest), lack of chemical fertilizer during the time of crop cultivation and due to other problems.

1.3. Rationale of study

French bean has high nutritional and health benefits. It contains high amount of both protein, fiber and exceptionally high in a wide variety of vitamins and minerals. Protein and fiber are most significant nutrient for weight loss. From the study it is found that people on a high fiber diet including beans experience less hunger. Cultivation of French bean helps to reduce the malnutrition in the developing country like Nepal. It can be consumed directly; seed as a vegetable or by making dal. Easily available cheap labour can be utilized to gain the income in a considerable short period of time. It's cultivation can be started with low capital investment and can fetch the high market value of seed. There is a high demand of French bean seed in a country in all seasons, so it is imported from other country at present. High fiber content in French Bean has many benefits, consumption of it reduce the cholesterol, aids in decreasing blood sugar levels and increasing health gut bacteria. Nepalese people are not much aware of the benefit of French beans cultivations, and they do not have scientific idea and knowledge of cultivations. This research can help the farmer to gain scientific knowledge in the field of cultivation and provide information about its benefit and can reduce the problem of food crisis, malnutrition. Healthy manpower can be produced for the development of country. Thus, we can conclude that the demand is increasing and this research may help to reduce the above mentioned problem and increase the seed production. The characters and yield of different varieties like Trishuli, Chaumase, semi long light, Semi long green and are studied thoroughly through this research which can be a milestone for the farmer.

1.4. Objective of study

1.4.1. Broad objective

- To evaluate different genotype of French bean for growth, yield and seed production in NARC, Khumaltar.

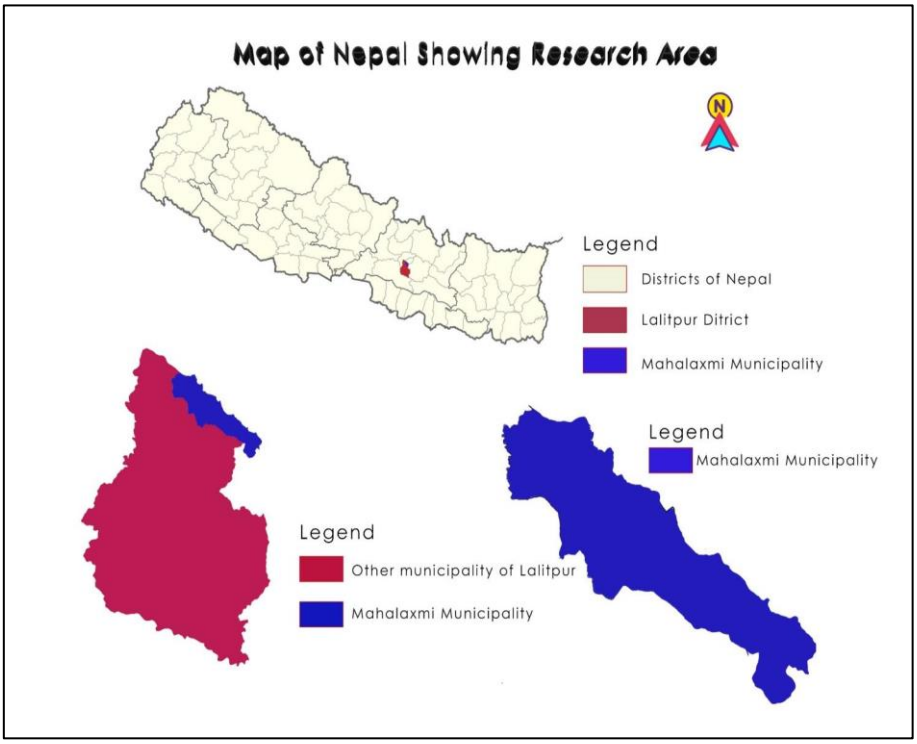
1.4.2. Specific objectives

- To study morphological growth and yield attributes of different French bean genotypes.
- To compare and contrast the overall performance between different varieties in a given location.
- To compare total yield and seed production of different varieties of French bean.

2.0. Material and method

2.1. Experimental site

The field experiment was conducted at Horticulture Research Division (HRD), Khumaltar (1332 masl) located at Longitude 27.6485° N and Latitude 85.3253° E situated at Province no. 3, Lalitpur district, Nepal.



2.2. Selection of cultivar

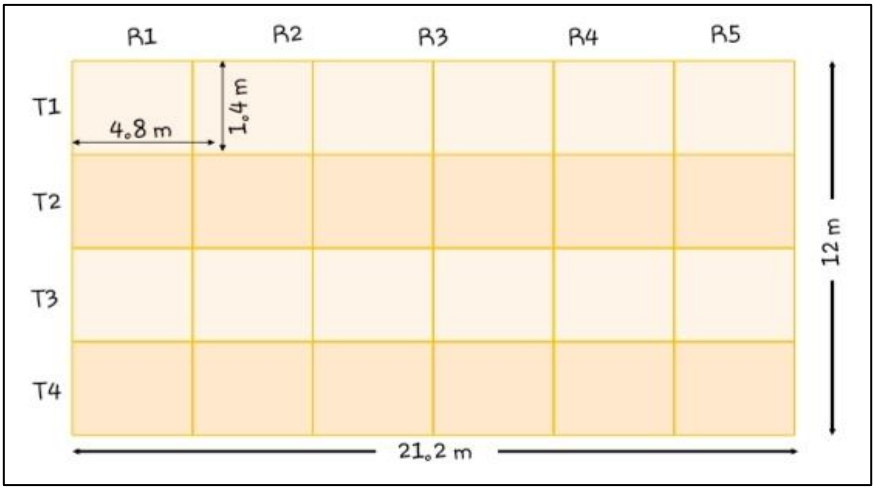
Among different varieties grown in Nepal we have selected the following varieties.

Table 1. Treatment used on research during august to October at khumaltar, lalitpur

S.N	Variety	Released Year	Days to maturity	Production (Mt/Ha)	Recommended Area
1	Trishuli	2051(1994)	70-75	14.0	Mid Hill and High hill
2	Chaumase	Not released			
3	Semi Long Green	2076(2019)	75-78	8.68	Mid Hill
4	Semi Long Light	2076(2019)	70-75	30-33	Mid Hill

2.3. Experimental design

Field experiment of 4 varieties as treatment having 5 replications will be conducted in the research site. Total 20 samples were taken and experiment was followed in Randomized Complete Block Design (RCBD). The total plot area was (21.2*12)m^2. The size of individual plot was (4.8*1.4)m^2. The distance within each replication was 1m and between replication was 50 cm.



2.4. Treatment details

The following are the treatment detail of French bean:

T_1=Trishuli

T_2=Chaumase

T_3=Semi Long Green

T_4=Semi Long Light

2.5. Cultural practices

2.5.1. Land Preparation

Land preparation was done at forth week of July. The field was ploughed with power tiller and was levelled accordingly. Weeds were removed mechanically. Malathion dusting was also done to kill soil insects.

2.5.2. Fertilizer Application

The standard recommended dose of fertilizers (80:120:60 NPK kg/ha) and 15 t/h FYM were applied. We applied 1.7kg N, 2.5 kg P and 1.25kg K for our plot size. Half dose of total nitrogen, full dose of potash and phosphorus fertilizers were incorporated at sowing time and the remaining half dose of nitrogen fertilizer was top dressed at 35 days of sowing.

2.5.3. Seed Sowing

Seed sowing was done at the end of July. Seeds were first treated with Bavistein at the rate of 2gm/kg. Seed was sown 5 cm deep in well prepared land. 2 seeds were dribbled per hole. The spacing was maintained at (120cm*20cm). After seeds were sown field was covered by jute sack to prevent moisture loss and to enhance germination. Seeds germinated 4 to 5 DAS.

2.5.4. Thinning and Gap filling

Thinning and gap filling was done at 10 DAS.

2.5.5. Staking

Staking was done with bamboo stick and ropes at 15 DAS after tendrils started appearing.

2.5.6. Weeding

Hand weeding was done. Firsthand weeding was done at 14 DAS, second weeding done at 34 DAS. Irrigation was also provided as per the crop requirement.

2.5.7. Chemical Application

Chemical pesticide; Cypermethrin was sprayed at 15 DAS (1ml/ltr). Roger was sprayed at 30 DAS at the rate of (1.5ml/ltr). Copperoxychloride paste was applied to plants infected with stem rot.

2.5.8. Lower Leaf Trimming

Diseased leaf infected with rust were cut down manually at 40 DAS.

2.5.9. Harvesting

Seeds were harvested in the month of October, at 70-74 DAS. Dried pods were collected from plants and seeds were collected manually. Pods and seeds were separated for measurement of weight.

2.6. Observation Taken

2.6.1. Plant Height

Height of five randomly selected plants was taken from each plot was measure from the ground level to the tip of the plant at 20 days interval from sowing to harvest. Boarder plants were excluded. Plant height was measured in cm with the help of scales and measuring tapes.

2.6.2. Flower Colour
Colour of flower was observed. The flower colour of chaumase and semi light long was recorded purple. Long Green Bean showed yellowish white flower and Trishuli showed creamy white flower.

2.6.3. No. of pod per plant at harvest
Total no. of pods per plant was counted and noted from sample plants.

2.6.4. Dry pod colour
Dry pod colour at harvest was noted. It was noted brown for all varieties.

2.6.5. Single pod weight at harvest
Weight of 10 pod was taken and average weight of single pod was calculated.

2.6.6. Pod Length
The pod length was determined by using scale. Length of 10 pod was taken and average was calculated.

2.6.7. Number of seed per pod
A total of 10 pod was taken and number of seed from each pod was calculated. An average of these seed was noted at last.

2.6.8. Seed yield per plant before drying
Weight of seeds from 10 pods from which average was taken and the remaning seed weight was weighted and added to get the total number of seeds per plant.

2.6.9. Seed yield per plant after drying
Seeds were allowed to dry in the sun and the total weight of seeds was weighted using weighing balance.

2.6.10. Seed weight per pod before drying
Weight of seeds from individual pods was taken using weighing balance.

2.6.11. Seed weight per pod after drying
Seeds were allowed to dry in the sun and was weighted afterwards using weighing balance.

2.6.12. Seed colour
Chaumase and Semi Light Long had black colored seeds, Long Green Bean had white colored seeds and Trishuli had brown colored seed.

2.6.13. 1000 Seed Weight
The harvested seeds were allowed to dry in the sun and the weight of randomly selected seeds were counted to get the weight of 1000 seeds of each replication and the average was calculated.

3.0. RESULT AND DISCUSION

3.1. Plant Height
Plant height in 20 DAS was found significantly different. The plant height was highest in Semi Long Light was found to be 46.27 cm and lowest was found in Chaumase that is 22.5cm. The plant height at 20 DAS of Trishuli, Semi long light and semi long green were not significantly different however with Four Season Bean it was found to be significantly different. A group researchers reported that the plant height in beans was influenced by the genotypes [2]. Plant Height at 40DAS was found to be significantly different among the genotypes Though the difference between plant height is non-significant, the plant height was highest in Semi long light and lowest in Trishuli which are 256.5 cm and 226.3 cm respectively. Semi Long Light is significantly different with Trishuli but with four season and semi long green it is statically at par. Plant Height at 60DAS was also found to be significantly different among the genotypes. Though the difference between plant height was non-significant, the tallest was found to be Semi Long Light which is 332cm and lowest height was found in Trishuli which is 294.48 cm.The plant height was found to be the highest in Semi Long Light which was in accordance with our result [4]. The plant height was least in Trishuli which was in line with our result [13].

Table 2. Plant height of different genotype at 20, 40, 60 DAS

Parameter	20 DAS	40DAS	60DAS
Trishuli	40.17^{a}	226.3^{b}	294.48^{b}
Chaumase	22.5^{b}	247.9^{ab}	318.03^{ab}
Semi long green	41.45^{a}	250.o^{ab}	313.11^{ab}
Semi long light	46.27^{a}	256.5^{a}	332.49^{a}
Grandmean	37.6	245.2	314.53
CV%	22.42	7.3	5.99
Sem **(±)**	3.77	7.96	8.44
LSD(0.05)	11.61	24.53	25.99
F- test	**	NS	NS

Note: * represent significant, ** represent moderately significant, *** represent highly significant, NS represent non-significant

3.2. Node number at harvest in main stem
The total number of nodes at harvest was found to be significantly different among the genotypes. Total number of nodes was maximum in Semi long Light 17.6 and minimum in Semi long green 13.6. Node number in Trishuli and Chaumase was found to be statistically similar that are 15.4 and 15.6 respectively.

3.3. Number of pod per plant at harvest

Number of pod per plant was found to be significantly different among genotypes. The number of pod was found to be highest in Chaumase bean 30.2cm followed Semi long green and Trishuli 29.2cm and 29.8cm and the lowest in Semi Long light 19.6cm.The variety Trishuli, Chaumse and Semi long green are statistically similar however they are significantly different with semi long green. A group researchers found the highest number of pod in Semi long light which is in contradictory with our results [3]. The differences in Number of pods/ plant among varieties might be seen because of the difference in their genetic make-up [3]. Sowing dates based on temperature variation significantly affects the flowering behavior and pod yield of bean varieties [6].

3.4. Single Pod weight at harvest

Average pod weight at harvest was found to be significantly different among the genotypes. The pod weight was highest in Trishuli 4.27gm and Lowest in Chaumse 2.67 gm. The weight of Trishuli varied significantly with Four Season, Semi Long green and semi long light. The above data also showed that the Chaumse and Semi Long Light are statistically similar. Yeild attributing character such as pod weight were markedly influenced by French bean cultivars themselves [14].

3.5. Pod length at Harvest

Average pod length at harvest was found to be significantly different among the genotypes. The pod length was found more in semi long green was 19.57cm and less in Chaumase Bean 15.58cm. Pod length of Trishuli was16.2 cm and semi long light was 17.98cm. Semi long green varies significantly with Trishuli, Four season and Semi long green. However, pod length of Trishuli and Chaumase are statisctically similar. Pod length of Trishuli was found to be 16.7 cm by which is almost similar with our research [15]. Sarangi also reported that the mean pod length of Selection 9 was 16.35cm [16]. Similar result was also reported by Sarangi which showed the mean pod length of Contender was 15.86cm [16].

3.6. No. of seed per pod

The total number of seed per pod was found to be significantly different among the genotypes. The highest number of seed per pod was recorded in Semi long green 8.6 and least number in Trishuli 7.6. Number of seed per pod in Kentuky Wonder was 7.77 which also resembles with our data (Sarangi, 2010).

Table 3. Yield attributing character of different genotype

Parameter	Node No at harvest in mainstem	No of pod per plant at harvest	Single pod weight at harvest	Pod length at harvest	No of seed per pod
Trishuli	15.4^{b}	29.2^{a}	4.27^{a}	16.2^{c}	7.6^{b}
Chaumase	15.6^{b}	30.2^{a}	2.67^{c}	15.58^{c}	8.2^{ab}
Semi long green	13.6^{c}	29.8^{a}	3.36^{b}	19.57^{a}	8.6^{a}
Semi long light	17.6^{a}	19.6^{b}	2.83^{c}	17.98^{b}	7.8^{b}
Grandmean	15.5	27.2	3.28	17.33	8.05
Cv%	7.54	18.81	11.10	2.64	6.5
Sem **(±)**	0.518	2.29	0.16	0.20	0.235
Lsd(0.05)	1.59	7.05	0.50	0.63	0.72
F-test	**	*	***	***	*

3.7. Seed weight per pod before drying

The seed weight per pod among the genotypes was highly significant. Trishuli had more seed weight per pod at harvest 3gm followed by Semi long green 2.37gm followed by Semi long light 2.18gm and the least in Chaumase 2.07gm. Seed weight per pod after drying also changed by the same ratio.

3.8. Seed weight per pod after drying

The seed weight per pod after drying was found to be highest in Trishuli 2.74gm followed by Semi long green 1.96gm, Semi long light 1.87gm. and least in Chaumase 1.79gm.

3.9. Seed weight per plant before drying

The seed weight per plant before drying was significant among the varieties. Seed weight per plant was more in Trishuli 64.58gm which revealed that the yield is more in it among the varieties. Trishuli was followed by Semi Long Green 61.58 gm, followed by Chaumase and the least in Semi Long Light. Seed weight per plant after drying changed by the same ratio after same drying.

3.10. Seed Weight Per Plant After Drying

The seed weight per plant after drying was significant among the verities. Seed weight per plant loss after drying is in the same ratio of each variety. Moisture loss in each variety is almost same. After drying seed weight of Trishuli become 58.87gm per plant followed by semi long green 55.15gm and the lowest is in semi long light 31.43gm.

3.11. Moisture%

Moisture was found significant among the varieties. The highest moisture was found after harvesting in semi long lite 23.75% followed by trishuli 15.52% and lowest moisture was found in Chaumase 10.29%.

Table 4. Table showing moisture loss of different genotype

Parameter	Seed weight per pod before drying	Seed wt per pod after drying	Seed weight per plant before drying	Seed weight per plant after drying	Moisture %
Trishuli	3.00^{a}	2.74^{a}	64.58^{a}	58.87^{a}	15.52^{b}
Chaumase	2.07^{b}	1.79^{b}	55.96^{a}	50.34^{a}	10.29^{b}
Semi long green	2.37^{b}	1.96^{b}	61.58^{a}	55.15^{a}	13.16^{b}

Semi long light	2.18[b]	1.87[b]	36.35[b]	31.43[b]	23.75[a]
Grandmean	2.40	2.09	54.62	49.0	15.68
Cv%	9.39	9.4	21.06	21.1	23.3
Sem **(±)**	0.10	0.08	5.15	4.62	1.63
Lsd(0.05)	0.31	0.27	15.85	14.24	5.03
F-test	***	***	**	**	***

3.12. Test Weight

The genotype differed significantly in terms of test weight. The above data showed that the test weight was the highest in Trishuli 266.2gm followed by semi long green 255.8gm followed by semi long light 224.8gm and the least was seen in Chaumase 207.2gm.

3.13. Yield

Yield is calculated on the basis of ton per hectare. Yield was found significant among the varieties. The highest yield was found in Trishuli 2.69 ton/ha followed by Chaumase 2.56 ton/ha Semi long green 2.33 ton/ha, and the lowest yield was seen in Semi long light 1.51 ton/ha.

Table 5. Yield of different genotype

Parameter	Test weight	Yield (ton/ha)
Trishuli	266.2[a]	2.69[a]
Chaumase	207.2[c]	2.56[a]
Semi long green	255.8[a]	2.33[a]
Semi long light	224.8[b]	1.51[b]
Grandmean	238.5	2.28
Cv%	3.9	21.1
Sem **(±)**	4.16	0.21
Lsd(0.05)	12.8	0.66
F-test	***	**

4.0. Conclusion

Plant height was found to be highest in Semi long light and lowest in Trishuli**.** Number of node was recorded maximum in Semi long light and least in Semi long Green. Total number of seed per pod was found to be highest in Semi long green and least number in Trishuli. Number of pod per plant was highest in Chaumase bean and lowest in Semi Long light. Single pod weight at harvest was highest in Trishuli and Lowest in Chaumase. Pod length at harvest was highest in Semi long green and lowest in Chaumase. Seed weight per pod before drying was highest in Trishuli and least in Chaumase. Seed weight per plant before drying was Trishuli which reached to after drying. It was seen least in Semi long light was before drying. The highest yield was found in Trishuli 2.69 ton/ha followed by Chaumase 2.56 ton/ha Semi long green 2.33 ton/ha, and the lowest yield was seen in Semi long light 1.51 ton/ha.

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