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PERFORMANCE EVALUATION OF DIFFERENT VARIETIES OF FRENCH BEAN (*PHASEOLUS VULGARIS* L.)

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ABSTRACT

A field experiment was carried out during the rabi season at the Instructional Farm of Arunachal University of Studies, Namsai, Arunachal Pradesh, to evaluate the growth, yield, and quality performance of five French bean (*Phaseolus vulgaris* L.) varieties Super Falguni, Anand, Anupam, Royal, and Roshni. The experiment was laid out in a randomized block design (RBD) with five treatments and four replications. Seeds were sown in the first week of October under standard agronomic practices. Significant varietal differences were observed for all the studied parameters. Among the tested genotypes, variety Anupam exhibited the most promising results across a wide range of growth and yield attributes, including maximum plant height (43.25 cm), number of leaves per plant (33.1), number of branches (12.9), flowers per peduncle (4.4), seeds per pod (6.13), and pods per plant (30.70). Anupam also recorded the highest pod length (14.46 cm), pod weight (11.13 g), dry weight (3.04 g), pod yield per plant (207.5 g), and total yield (24.62 kg/ha), making it the most productive variety in the trial. In terms of quality parameters, the highest total soluble solids (T.S.S.) content was observed in both Anupam and Royal (6.49 °Brix), while titratable acidity was highest in Anand (0.062%), and Roshni recorded the highest ascorbic acid content (15.65 mg/100 g). The results of this investigation clearly indicate that Anupam combines superior agronomic traits with desirable quality characteristics, making it a suitable candidate for commercial cultivation under the agro-climatic conditions of Namsai. Further studies across seasons and locations may help validate its performance consistency.
Keywords **:** French bean, Namsai, Arunachal Pradesh, Performance.

Introduction

French bean (*Phaseolus vulgaris* L.) belongs to the family Fabaceae and it is native of South America and has a chromosome of 2n=22. It is highly self-pollinated and annual crop. French bean is one of the most important leguminous vegetable crops of North eastern region. It is cultivated for the tender vegetable, shelled green beans and dry beans. It is very rich in protein, vitamins and minerals. It is gaining lot of importance due to its short duration and high production potential as well as its high nutritive value. In some region, it is cultivated in rice fallow during spring summer and on hill slopes during autumn winter season. It has possibility to be grown round the year in some region where irrigation facilities are available during dry period. French bean is a great source of dietary fiber, which is quickly absorbed by the digestive system. French beans are a good source of minerals such as Manganese which has antioxidant properties and supports metabolism. French beans are good for regulating the heart, bones, and gut health. In India, it is mostly grown for tender green pods, while in the USA it is grown for processing in large quantities. In India, it is mainly grown in Himachal Pradesh, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Among the Northeastern state, Assam is the highest producer of beans with an annual production of 27.47 thousand metric tons. French bean is a tender warm season vegetable which cannot tolerate frost, high temperature and rainfall. The ideal temperature range for proper growth of the crop is 10-

27℃. Above 30℃, the flower drop is a serious problem. Similarly, below 5℃ the flowers and developing pods and branches are damaged. There are two major types of French bean found in the market today- bush type and pole type. French bean variety having the bush growth habit are desirable because of their early bearing nature and dwarf nature, which requires less spacing and better facilitation of intercultural operations when compared to pole types and semi pole types. Hence, bush type varieties were considered for this present study. (Kandula *et al.,* 2022). The majority of the available hybrid French bean are less preferred by the consumers due to presence of the smell while cooking and farmers are lacking the varieties with all the referred characters such as high yielding, disease resistance and at the same time with high cooking quality and organoleptic value. 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. The performance of varieties is highly influenced by its growing environment and management practices. Evaluation of crop varieties in a particular agro-climatic region is highly necessary to judge their performance on that region that helps to select the best types and to promote these identified types among the growers. Meanwhile, bringing in new French bean cultivars will help diversify the market and provide customers more options. Therefore, the present study will be useful in enhancing basic understanding about French bean farming and useful to investigate how French bean perform under Namsai condition, it will be useful for determining which French bean variety or varieties are suitable for Namsai, Arunachal Pradesh. So, in this trial we are going to evaluate 5 French bean varieties to select best performing one with respect to earliness, fruit quality and yield in Namsai to encourage the local farmers to grow French bean.

Materials and Method

The present study was carried out at the instructional farm of the Arunachal University of Studies in Namsai, Arunachal Pradesh, between 2023-25. Namsai is located at 27.66894 N latitude and 95.87135 E longitude, with an elevation of 156 m above mean sea level. The geographical area covered is 1587 square kilometres, including 191.31 square kilometres under agricultural use (National Informatics Centre, 1522). Namsai's climate is subtropical and falls under the agro-climatic zone of the Eastern Himalayas region (KVK, Momomg, Namsai District under ICAR, Centre Basar, Arunachal Pradesh), with an average rainfall of 3500-4500mm and temperatures ranging from 28℃ to 45℃ in summer and 10℃ to 25℃ in winter. The experimental field's soil type is sandy loam, which is slightly acidic in nature (pH = 6.73). Performance evaluation of five varieties namely Super Falguni, Anand, Anupam, Royal and Roshni were evaluated for growth, yield and quality traits. Data on growth, yield and yield attributing characters were collected at appropriate stages and for the quality traits lab analysis was done.

The experiment was conducted in randomized block design (RBD) with four replications. The experimental site was well prepared and all the necessary cultural practices like ploughing, weeding, irrigation, fertilizer application were followed for the healthy growth of the experimental material. Each treatment was represented by a plot size of 1.48 m x 0.96 m at a spacing of 45 cm x 15 cm. Observations were recorded for growth attributes are plant height (cm) which was measured using centimetre-scale from cotyledon scar to tip of the plant while no of leaves, no. of branches, days to 50% flowering and no. of flower in each peduncle were recorded manually on five randomly selected plants from each plot of each replication separately as well as yield attributing character were recorded as per the standard method and averaged it. Yield attributes were also recorded at physiological maturity stages and the parameter are no. of pods per plant**,** pod weight (g), pod length (cm), no. of seed per pod, pod yield per plant, yield per plot and yield per hac. The quality attributes were measured using standard procedures. The harvested pods were crushed and juice was passed through a double layer of mesh cloth, collected in a tube, shaken well for about 2 minutes and then TSS was determined with the help of digital refractometer and presented as °Brix. The ascorbic acid was determined by the volumetric method as described by Sadasivam and Manickam (1508). Titratable acidity (TA) was determined by titrating the juice against a standard alkali solution (0.1 N NaOH) using the standard method of AOAC (1980).

Results and Discussion

Growth Attributes

Significant differences in growth attributes among the treatments were observed, as presented in Table 1. The growth attributes like plant height, number of leaves per plant, number of branches per plant, days to 50 % flowering and number of flowers in each peduncle were different significantly. Pooled data

revealed that variety T_3 (Anupam) recorded maximum values of growth attributes like plant height (43.25 cm), number of leaves per plant (33.1), number of branches per plant (12.9), days to 50% flowering (45 days) and number of flowers in each peduncle . where the values were significantly superior as compared with other varieties calculated. Similar results on plant height were reported by Rana *et al.* (2020) that the maximum plant height at harvest (63.61 cm) was recorded in Anupam, showing superiority over another cultivar. Similar findings on number of leaves per plant were reported by Magray *et al.* (2023) that the number of leaves per plant at harvest (35.58), was recorded in Anupam. Neupane *et al.* (2008) reported that the flowering days in beans were influenced by genotype. They noted that flowering varied from 40 to 84 days, depending on the bean genotype. Dhakal *et al*. (2020) revealed that the number of flower buds found in Trishuli with an average of 4.8. Pandey *et al.* (2011) and Das *et al.* (2018) Environmental conditions, mainly air temperature and rainfall, greatly affect the growth and development of bean plants. Brewster (1983) reported that temperature influences the responses of many plant species to photoperiod, growth, tuber development, and flowering.

Yield Attributes

The yield attributes like number of pods per plant, pod length, number of seeds per pods, pod weight, pod yield per plant, yield per plot and yield per hectare varied among five varieties. It was revealed that variety Anupam (T_3) recorded maximum values of number of pods per plant (30.70), Pod length (14.46 cm), number of seeds per pod (6.13), Pod weight (11.29 g), Pod yield per plant (207.5 g), yield per plot (2.882 kg/m²) and yield per hac (24.62 kg/ha) where the values were significantly maximum as compared to other varieties. Similar results on number of pods per plant were reported by Baruah *et al.* (2022) being the shrub type French bean varieties, the number of pods Arka Komal 26.04. Jena *et al.* (2020) maximum number of pods per plant (35.64). Neupane *et al.* (2003) noted that the variety affected the number of pods per plant in the common bean. The quantity of pods on each plant is a crucial yield-related feature, as a rise in the number of pods per plant will ultimately enhance the crop yield. In this experiment, the differences in pod counts per plant across various varieties may result from genetic inheritance. Ramana *et al.* (2010) reported differences in the number of pods per plant across various varieties. Meena *et al.* (2018) observed that this could be because the agro-climatic conditions at the experimental site during the growing season were most favourable for this genotype. Similar results on pod length were reported by Baruah *et al*. (2022): the shrub-type French bean varieties Arka Komal (pod length: 14.46 cm). Whankate *et al.* (2018) Genetic heterogeneity in various germplasm may be the cause of the difference in the quantity of seeds per pod.

According to Reddy *et al.* (2010) they also found that varietal variation and diverse sowing dates are important factors that contribute to high output. Baruah *et al.* (2022) the variety Arka Sukomal was found to produce overall highest yield per hectare (20.75 kg/ha), both of which are significantly higher than Arka Komal 14.19 kg/ha. Das (2017) similarly, lowest pod yield was obtained from Falguni (15.67 kg/ha), the highest yield was recorded in Special Jhhati Beans (21.53 kg/ha) followed by Arka Komal (21.03 kg/ha), Victoria (20.58 kg/ha), Nandini (20.15 kg/ha) and Basuki (19.69 kg/ha).

Quality parameters

According to analytical data on the French bean's moisture content, the highest moisture content was recorded in treatment T_5 (Anand), with a value of 15.23%, which was significantly higher than all other treatments. Thapa *et al*. (2022) the highest moisture was found after harvesting in semi long lite 23.75% followed by Trishuli 15.52 %.

The highest TSS value was recorded in treatments T_3 (Anupam) and T_4 (Royal), both registering 6.49 Brix°, and found to be statistically *at par* with each other. Rana *et al*. (2020) total soluble solid was recorded in Anupam (6.50 Brix). The similar findings were reported by Sarangi *et al*. (2010) in French bean. The differences in ascorbic acid levels were noted in relation to the various types of French beans.

The highest ascorbic acid content was recorded in treatment T_5 (Anand), with a value of 15.65 mg/100 g. According to Das (2017), among the several kinds, Shagun had the highest ascorbic acid concentration (18.86 mg/100g fresh pod).

Among all the treatments, the highest acidity was recorded in T_2 (Roshni) with a value of 0.062%, indicating a comparatively higher acidic content. This was followed by T_4 (Royal) and T_3 (Anupam), which recorded acidity values of 0.045% and 0.043%, respectively, and were statistically *at par* with each other. Garzón-García *et al.* (2021) found that green beans (*Phaseolus vulgaris* L.) at the same maturity condition as the ones employed in this study had a higher titratable acidity value (1.6 g citric acid 100 g^{-1}).

Table 1: Performance of different varieties of French bean on growth parameters

	Plant height (cm)				No. of leaves				No. of branches			
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
T_1	17.3^{d}	27.25^{b}	35.55^{b}	37.7^{b}	6.40^{c}	14.05^{c}	26.90^{c}	28.1^{c}	3.65^{b}	6.10^{e}	10.00^{d}	11.5^{b}
T_2	19.35^{c}	30.60^{ab}	36.40^{b}	38.5^{b}	6.50^{b}	18.80^{b}	29.05b	30.7^{b}	3.85^{b}	6.25^{d}	10.10^{d}	11.65^{b}
T_3	19.75^{a}	31.45^{a}	41.35^{a}	43.25^{a}	6.65^{a}	21.90^{a}	32.10^{a}	33.1^{a}	5.30^{a}	8.05^{a}	11.30^{a}	12.9^{a}
T_4	19.65^{b}	31.05^{ab}	38.15^{ab}	40.45^{ab}	6.65^{a}	21.80^{a}	29.75^{b}	30.15^{b}	3.90^{b}	7.55^{b}	10.75^{b}	12.7^{a}
T_5	19.45^{c}	30.90^{b}	38.15^{ab}	40.1^{ab}	6.60^{b}	20.75^{ab}	29.60^{b}	30.9^{b}	3.90^{b}	7.00^{cb}	10.40^{c}	12.4^{a}
C.D. (5%)	0.532	0.69	3.25	3.24	0.109	2.33	0.872	0.971	0.61	0.117	0.194	0.74
SEd(±)	0.242	0.313	1.47	1.47	0.049	1.05	0.396	0.441	0.27	0.053	0.088	0.33

Table 2: Performance of different varieties of French bean on growth parameters

	Days to 50% flowering	No. of flowers in each peduncle
T_1	48^{a}	3.6^{b}
T_2	47^{b}	3.7^{b}
T_3	45^{c}	4.4^{a}
T_4	45^{c}	4.2^{a}
T_5	46^{b}	4.1^{a}
CD (5%)	1.4	0.34
SEd(±)	0.636	0.15

Table 3: Performance of different varieties of French bean on yield parameters

	Days to harvest	No. of pods per plant	Pod length (cm)	No. of seeds per pod	Pod weight (g)	Dry weight (g)	Pod yield/ plant (g)	Yield per plot (kg/m^2)	Yield per hectare (kg/ha)
T_1	59.00^{a}	25.90^{c}	12.03^{c}	5.40^{b}	7.36^{c}	2.93^{b}	174.25^{d}	2.416^{c}	19.96^{c}
T_2	57.00^{b}	26.20^{c}	12.74^{bc}	5.35^{b}	9.97^{b}	2.91^{a}	184.7^{c}	2.44^{c}	20.20^{c}
T_3	55.00^{d}	30.70^{a}	14.46^{a}	6.13^{a}	11.29^{a}	3.04^{a}	207.5^{a}	2.882^{a}	24.62^{a}
T_4	55.00^{d}	28.20^{b}	14.11^{a}	6.10^{a}	11.12^{a}	3.00^{a}	188.7^{b}	2.682^{b}	22.62^{b}
T_5	56.00^{c}	28.00^{b}	13.54^{ab}	5.85^{a}	10.08^{c}	2.82^{c}	185.8^{c}	2.481^{c}	20.61^{c}
CD (5%)	2.003	1.394	0.987	0.399	0.423	0.06	12.381	0.155	1.55
SEd(±)	0.909	0.633	0.448	0.181	0.192	0.02	5.62	0.07	0.704

Table 4: Performance of different varieties of French bean on quality parameters

	Moisture content %	Total soluble solids (TSS) Brix°	Ascorbic acid (mg/100g)	Titratable acidity (%)
T_1	13.08^{c}	5.91^{ab}	15.52^{a}	0.039^{b}
T_2	13.24^{c}	6.15^{a}	15.01^{a}	0.048^{a}
T_3	11.21^{d}	6.49^{a}	14.12^{b}	0.043^{a}
T_4	14.81^{b}	6.49^{a}	14.74^{b}	0.045^{a}
T_5	15.23^{a}	5.36^{b}	15.65^{a}	0.035^{b}
CD (5%)	2.09	0.77	0.379	0.328
SEd(±)	0.95	0.349	0.172	0.149

Conclusion

The French bean variety Anupam (T_3) demonstrated superior performance across multiple parameters, including plant height, number of leaves, number of pods per plant, yield per plot and overall quality attributes. Its highest yield and best growth characteristics, Anupam (T_3) is recommended for commercial cultivation under Namsai conditions to maximize productivity and profitability. In conclusion, the results indicate that Anupam is a highly suitable French bean variety for cultivation in the agro-climatic region of Namsai, Arunachal Pradesh. Its superior performance in terms of growth, yield, and quality traits makes it a strong candidate for enhancing local bean production. Nevertheless, to ensure its broader adaptability and performance reliability, further validation through multi-location and multi-season trials is recommended. Such studies will help establish the varietal consistency of Anupam and support its recommendation for wider commercial adoption.

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