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Comparative Performance of Different Adzuki Bean (*Vigna angularis* (Willd.) Genotypes under Organic and Conventional Farming Conditions

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Abstract: A field experiment was conducted in randomized block design during *Kharif* season 2023-2024 to evaluate the effect of inorganic, organic and Natural Farming on fifteen selected genotypes of adzuki bean for growth parameters. Significant differences in the plant height, number of branches, pods per plant, seeds per pod and seed yield were obtained in genotypes as well as different production systems (inorganic, organic and Natural Farming), whereas no significant difference were obtained in pod length. Simultaneously interaction effect was significant for plant height and seed yield whereas, there were no significant interaction obtained for number of branches per plant, number of pods, seeds per pod and pod length. The overall finding of this study indicated that Natural Farming production system can be used to achieve better growth and yield of adzuki bean.

Keywords: Adzuki bean, rganic, inorganic, *kharif* season, natural farming.

INTRODUCTION

Beans are among the most important grain legumes cultivated worldwide. Owing to their nutritional and economic significance, beans constitute a major food source in many countries. In addition to their nutritional value, beans contain a wide range of bioactive compounds, particularly polyphenols, which possess significant health-promoting properties (Hayat *et al.*, 2014). Several bean species are cultivated for human consumption as well as animal feed, including moth bean (*Vigna aconitifolia*), adzuki bean (*Vigna angularis*), urd bean (*Vigna mungo*), mung bean (*Vigna radiata*), rice bean (*Vigna umbellata*), cowpea (*Vigna unguiculata*), faba bean (*Vicia faba*), and soybean (*Glycine max*).

Among these species, adzuki bean (*Vigna angularis* (Willd.) has attracted considerable attention because of its nutritional and functional attributes. The crop is rich in proteins, dietary fiber, vitamins, minerals, and bioactive compounds with strong antioxidant activity. Adzuki bean exhibits remarkable free-radical scavenging capacity, which may help reduce oxidative stress associated with inflammation, atherosclerosis, cardiovascular disorders, and certain forms of cancer. Furthermore, it is considered a beneficial food for individuals with non-insulin-dependent diabetes mellitus, as its consumption has been reported to contribute to lower postprandial blood glucose levels (Lee *et al.*, 2017).

In recent years, organic farming has gained considerable global importance due to increasing consumer demand for food products produced without the use of synthetic fertilizers

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and pesticides. Organically produced foods are generally perceived as healthier, safer, and environmentally sustainable compared with conventionally grown products. Growing awareness regarding food safety and environmental conservation has further encouraged consumers to prefer organic products. The application of organic manures has been reported to improve plant growth, development, and productivity by enhancing soil fertility and biological activity (Badar *et al.*, 2015). Information on the performance of adzuki bean genotypes under different farming systems is limited under Indian conditions. As genotypes may respond differently to organic, inorganic, and natural farming practices, their evaluation is essential for identifying high-yielding and sustainable cultivars. Therefore, the present study was undertaken to assess the growth and yield performance of adzuki bean genotypes under different production systems and identify suitable genotypes for sustainable cultivation.

MATERIALS AND METHODS

The field experiment was conducted during the kharif seasons of 2023 and 2024 at the Experimental Farm of the Department of Organic Agriculture and Natural Farming (NF), CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh, India. The experiment was laid out in a Randomized Block Design with three replications to evaluate fifteen adzuki bean (*Vigna angularis* (Willd.) genotypes under three production systems, viz., inorganic farming, organic farming, and Natural Farming. Under the inorganic production system, fertilizers were applied at the rate of 20:40:20 kg N:P:K ha^{-1} at the time of sowing. In the organic production system, vermicompost was applied as a basal dose at 5 t ha^{-1}. Under the NF system, Ghanajeevamrit was applied as a basal dose at 40 kg ha^{-1}. Ghanajeevamrit was prepared by fermenting a mixture of 100 kg dung from indigenous cow, buffalo, and goat, 1 kg jaggery, 2 kg pulse flour, a handful of soil collected from the field bund, and 5 L cow urine for 48 h under shade. The fermented material was subsequently dried under sunlight and pulverized into fine particles before application. Additionally, Jeevamrit was applied as a 10% foliar spray under the NF system at 15-day intervals until physiological maturity of the crop. Jeevamrit was prepared by mixing 10 kg fresh cow dung, 10 L aged cow urine, 2 kg jaggery, 2 kg pulse flour, and a handful of field soil in 200 L water, followed by thorough mixing and fermentation. The crop was sown on 30 May 2023 and 30 May **2024**. Each experimental plot consisted of two rows of 6 m length spaced 30 cm apart. Five plants were randomly selected and tagged from each plot for recording observations on plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), seeds per pod, and seed yield (kg ha^{-1}).

Statistical analysis: The recorded data were subjected to analysis of variance (ANOVA) appropriate for a factorial randomized block design, and treatment means were compared at the 5% level of significance.

RESULTS AND DISCUSSION

Plant Height

Plant height varied significantly among genotypes and production systems. Across production systems, genotype EC-340286 recorded the highest mean plant height (146.93 cm), while HPU-51 exhibited the lowest (127.53 cm). Among the production systems, NF produced the tallest plants with a mean height of 144.33 cm, followed by the organic (128.97 cm) and inorganic (110.78 cm) systems. Under inorganic, organic and NF conditions, EC-340286 recorded the maximum plant height of 147.98 cm, 125.20 cm and 167.60 cm, respectively, whereas the minimum values were observed in HPU-51 (89.38 cm),

ADHP-8 (106.40 cm) and HPU-51 (156.00 cm), respectively. The significant genotype × production system interaction indicated differential genotype responses under varying production systems.

Number of Branches/Plant

The number of branches per plant differed significantly among genotypes, with ADHP-2 recording the highest mean value (3.47), followed by ADHP-10 (3.13) and ADHP-3 (3.07), whereas HPU-51 exhibited the lowest mean number of branches per plant (1.93). Among the production systems, NF recorded the highest average number of branches per plant (2.99), followed by the organic (2.65) and inorganic (2.37) systems. Under inorganic conditions, ADHP-10 produced the maximum number of branches per plant (3.80), while EC-340286 recorded the minimum (1.40). Under organic and NF conditions, ADHP-2 recorded the highest number of branches per plant (3.60 and 4.40, respectively), whereas the lowest values were observed in LOCAL TOTRU (1.80) and HPU-51 (2.00), respectively. Genotypic differences were significant for this trait, while the effect of production systems was non-significant.

Overall, the NF production system promoted greater plant height and branching compared to the inorganic and organic production systems, indicating its potential for enhancing vegetative growth in adzuki bean genotypes.

Pods/Plant

The number of pods per plant differed significantly among genotypes and production systems. Among the genotypes, **ADHP-7** recorded the highest mean number of pods per plant **(44.07),** followed by **ADHP-1 (40.60)** and **ADHP-5 (37.73),** while the lowest value was observed in **LOCAL TOTRU (26.27).** Under inorganic and organic production systems, **ADHP-1** produced the maximum number of pods per plant (**33.00** and **45.60**, respectively), whereas under **NF, ADHP-7** recorded the highest value (**72.00).** The lowest values were observed in **LOCAL TOTRU (21.60)** under inorganic, **HPU-51 (30.80)** under organic, and **LOCAL TOTRU (35.40)** under NF conditions. On a production system basis, the highest mean number of pods per plant was recorded under **NF (40.00),** followed by **organic (34.49)** and **inorganic (24.31)** systems. The effects of genotypes and production systems were significant, while their interaction was found to be non-significant.

Pod Length

The mean pod length among the genotypes ranged from **7.30 to 9.55 cm.** The maximum mean pod length was recorded in **ADHP-1 (9.55 cm),** followed by **ADHP-2 (8.80 cm)** and **ADHP-5 (8.44 cm),** whereas the minimum was observed in **HPU-51 (7.30 cm),** followed by **ADHP-4 (7.48 cm)** and **ADHP-10 (7.51 cm).** Among the production systems, the highest mean pod length was recorded under the **inorganic system (8.43 cm),** followed by **NF (8.24 cm)** and the **organic system (8.02 cm).** However, the effects of genotypes and production systems on pod length were found to be **non-significant.**

Overall, NF proved superior for enhancing pods per plant, whereas pod length remained relatively stable across genotypes and production systems.

Seeds/Pod

The mean number of seeds per pod varied from **6.93 to 8.60** among the genotypes. The highest mean number of seeds per pod was recorded in **ADHP-1 (8.60),** followed by **ADHP-7 (8.40)** and **ADHP-6 (7.87),** whereas the lowest mean value was observed in **ADHP-5 (6.93),** followed by **LOCAL TOTRU (7.07)** and **EC-340245 (7.80).**

Among the production systems, the highest overall mean number of seeds per

Table 1: Effect of production system on plant height (cm) and number of branches per plant in adzuki bean genotypes

Genotypes	*Plant height (cm)*			*Number of branches per plant*		
	Inorganic	*Organic*	*NF**	*Inorganic*	*Organic*	*NF**
ADHP-1	129.08	121.80	148.38	3.60	3.20	3.00
ADHP-2	120.80	143.40	130.46	2.40	3.60	4.40
ADHP-3	115.00	122.68	139.64	2.60	3.40	3.20
ADHP-4	114.20	162.60	126.40	2.40	2.20	3.40
ADHP-5	99.80	126.90	152.36	2.60	3.00	2.20
ADHP-6	117.60	121.00	146.46	2.20	3.00	4.20
ADHP-7	99.60	140.60	155.90	2.00	2.80	2.60
ADHP-8	88.20	136.40	168.80	2.20	2.60	3.00
ADHP-9	90.20	123.20	97.36	2.40	2.60	2.60
ADHP-10	88.86	108.20	123.30	3.80	2.20	3.40
EC-340245	147.98	125.20	167.60	2.00	2.40	3.20
EC-030270	129.06	139.40	119.40	2.20	2.40	2.80
EC-340286	118.88	122.64	99.10	1.40	2.40	2.60
LOCAL TOTRU	113.02	103.38	173.80	2.20	1.80	2.20
HPU-51	89.38	137.20	156.00	1.60	2.20	2.00
C D (P=0.05)	Genotypes	Production System	Interaction	Genotypes	Production System	Interaction
	21.248	9.502	36.803	0.802	0.359	N/A

*NF = Natural Farming

Table 2: Effect of production system on pods per plant (cm) and pod length in adzuki bean genotypes

Genotypes	*Pods per plant (cm)*		*Pod length*	***Number of branches per plant***		
	Inorganic	*Organic*	*NF**	*Inorganic*	*Organic*	*NF**
ADHP-1	33.00	45.60	43.20	9.38	9.48	9.78
ADHP-2	21.40	39.40	50.40	8.34	9.48	8.58
ADHP-3	29.60	38.80	35.20	8.22	8.18	8.22
ADHP-4	19.80	28.80	37.00	7.36	8.12	6.96
ADHP-5	24.20	44.00	45.00	8.40	8.50	8.42
ADHP-6	29.20	39.60	36.20	8.76	8.62	9.26
ADHP-7	23.20	37.00	72.00	8.34	7.50	8.68
ADHP-8	18.20	39.80	37.20	8.94	8.84	7.82
ADHP-9	21.60	29.80	33.80	8.50	7.64	8.56
ADHP-10	23.80	28.00	35.80	6.68	7.64	8.20
EC-340245	29.80	31.80	44.00	8.24	8.48	7.86
EC-030270	28.20	26.00	37.00	8.98	6.54	7.92
EC-340286	23.60	36.20	25.20	8.32	7.84	8.16
LOCAL TOTRU	21.60	21.80	35.40	9.28	5.72	6.90
HPU-51	17.40	30.80	32.60	8.76	7.82	8.30
C D (P=0.05)	Genotypes	Production System	Interaction	Genotypes	Production System	Interaction
	11.071	4.951	NS	NS	NS	NS

*NF = Natural Farming

Table 3: Effect of Production System on Seeds per Pod and Seed Yield (kg/ha) in Adzuki Bean Genotypes

Genotypes	*Seeds/Pod (No.)*			*Seed Yield (kg/ha)*		
	Inorganic	*Organic*	*NF**	*Inorganic*	*Organic*	*NF**
ADHP-1	8.40	8.80	8.60	208.3	833.3	1166.7
ADHP-2	8.60	8.40	7.80	208.3	1416.7	486.1
ADHP-3	7.80	7.40	7.80	333.3	875.0	444.4
ADHP-4	7.20	6.80	6.80	222.2	666.7	375.0
ADHP-5	7.80	7.80	8.00	222.2	597.2	708.3
ADHP-6	8.60	8.00	8.60	277.8	736.1	916.7
ADHP-7	7.80	6.60	7.80	333.3	888.9	2152.8
ADHP-8	8.40	7.40	7.80	138.9	1375.0	930.6
ADHP-9	7.00	6.80	8.20	361.1	611.1	1638.9
ADHP-10	8.40	8.00	7.80	305.6	297.2	97.2
EC-340245	9.00	6.00	7.60	222.2	375.0	625.0
EC-030270	8.20	7.60	7.40	250.0	361.1	777.8
EC-340286	8.40	5.20	6.60	138.9	138.9	291.7
LOCAL TOTRU	9.40	7.20	7.20	305.6	638.9	805.6
HPU-51	8.20	7.20	7.20	222.2	652.8	180.6
CD (P=0.05)	Genotypes	Production System	Interaction	Genotypes	Production System	Interaction
	1.099	0.451	NS	15.978	7.146	27.675

*NF = Natural Farming

pod was recorded under the **inorganic system (8.20),** followed by **NF (7.67)** and **organic production system (7.36).** Under the inorganic production system, the maximum number of seeds per pod was observed in **ADHP-1 and EC-340286 (8.40 each)**, while the minimum value was recorded in **ADHP-5 (7.20).** In the organic system, **ADHP-1 (8.80)** recorded the highest number of seeds per pod, whereas **ADHP-8 (6.60)** recorded the lowest value. Under NF, the highest number of seeds per pod was recorded in **ADHP-1, ADHP-6 and ADHP-7 (8.60 each),** while the lowest value was observed in **LOCAL TOTRU (6.60).**

The analysis of variance revealed significant differences among genotypes and production systems for seeds per pod, while the genotype × production system interaction was non-significant.

Seed Yield

The mean seed yield ranged from **263.9 to 1060.2 kg ha^{-1}** among the genotypes. The highest mean seed yield was recorded in **ADHP-8 (1060.2 kg ha^{-1}),** followed by **ADHP-9 (888.9 kg ha^{-1})** and **ADHP-10 (851.9 kg ha^{-1}).** The lowest mean seed yield was observed in **LOCAL TOTRU (263.9 kg ha^{-1}),** followed by **HPU-51 (416.7 kg ha^{-1})** and **EC-340286 (467.6 kg ha^{-1}).**

Production systems exerted a significant influence on seed yield. The highest overall mean seed yield was recorded under **organic production system (710.2 kg ha^{-1}),** followed by **NF (773.2 kg ha^{-1})** and **inorganic production system (222.2 kg ha^{-1}).** The maximum seed yield **(1968.0 kg ha^{-1})** was obtained from **ADHP-10** under NF, whereas the minimum yield (**111.1 kg ha^{-1})** was recorded in **ADHP-10** under the inorganic production system.

The analysis of variance showed significant differences among genotypes and production systems for seed yield. The genotype × production system interaction was also significant, indicating differential response of genotypes to the production systems with respect to seed yield.

CONCLUSION

Based on the findings of the present investigation, it can be concluded that the **Natural Farming** production system significantly improved the growth and yield attributes of adzuki bean compared with the other production systems. The enhanced performance under NF was reflected in increased plant height, number of branches per plant, number of pods per plant, and seed yield. Among the evaluated genotypes under the NF production system, **LOCAL TOTRU** recorded the maximum plant height, **ADHP-2** produced the highest number of branches per plant, **ADHP-7** recorded the highest number of pods per plant and the highest seed yield, **ADHP-1** produced the longest pods, while **ADHP-1** and **ADHP-6** recorded the highest number of seeds per pod. Considering the overall performance across the three production systems (inorganic, organic, and Natural Farming), the genotypes **ADHP-7, ADHP-8,** and **ADHP-9** were identified as the most promising for seed yield and may be recommended for cultivation and further evaluation in similar agro-ecological conditions.

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