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Performance of different genotypes of Adzuki bean [*Vigna angularis* (Willd.) Ohwi & Ohashi] under inorganic and organic farming conditions

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Abstract

A field experiment was conducted in randomized block design (RBD) during *Kharif* season 2018-2019 to evaluate the effect of inorganic, organic and Zero Budget Natural Farming (ZBNF) 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 Zero Budget 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 Zero Budget Natural Farming production system can be used to achieve better growth and yield of adzuki bean.

Key words: Adzuki bean, organic, inorganic, *Kharif* season.

Legumes are an imperative part of Indian Agriculture. India holds a major position among the pulse producing countries in the world. Pulses and beans form an essential protein supplement for the cereal based food and play a significant role in traditional diets all over the world. Legumes are widely grown and consumed in various regions, form an excellent source of proteins, complex carbohydrates and fairly good source of minerals, vitamins and polyunsaturated fatty acids (Chung *et al.* 2008).

Organic farming has great importance globally. In view of the increasing demand for organically grown food products without synthetic insecticides and fertilizers are perceived as more healthier and safer than the inorganic food products. Health awareness on safe food consumption and environment friendly behavior has led to the selection of organic foods by the consumers. Application of organic manures gives significant effect on development of crop plants and growth (Badar *et al.* 2015). Beans are the member of the Leguminosae, belong to family Phaseoleae and sub-family Papilionoideae. Because of economic and nutritional quality these are used as essential food crop in each part of the world. Besides providing nutrients these also contain rich variety of polyphenolic compounds with potential health benefits (Hayat *et al.* 2014). Among different bean species, some are used solely as human food and some as animal feed as well as human consumption. These include *Vigna* species i.e. moth bean *(V. aconitifolia*), azuki bean (*V. angularis*), urd bean (*V. mungo*), mung bean (*V. radiata*), rice bean (*V. umbellatta*) and cowpea (*V. unguiculata*), *Vicia* genus i.e. broad or faba bean (*faba*) and (*Glycine max*). Presently, adzuki beans have attracted attention because of their considerable health benefits and functional components. It has strong free radical scavenging capacity, which can prevent and control oxidative damage caused by inflammation, atherosclerosis, cardiovascular disease, and even cancer. These are also an ideal food for non-insulin-dependent diabetes mellitus patients, because after a meal, they can effectively lower plasma glucose (Lee *et al.* 2017).

Adzuki bean (*Vigna angularis*) was domesticated in China 12,000 years ago and is grown in more than 30 countries of the world, especially in East Asia. It is an important source of protein, starch, mineral elements and vitamins. It is also referred as "weight loss bean" because of its low caloric and fat content, digestible protein and abundant bioactive compounds. It has

broad adaptability, high tolerance to poor soil fertility and is a high-value rotation crop that contributes to the improvement of soil condition by nitrogen fixation (Liu *et al.* 2017).

Materials and Methods

The field experiment was conducted in randomized block design (RBD) during *Kharif* season of 2018-2019 at the Experimental- Farm of the Department of Organic Agriculture and Natural Farming, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The fifteen genotypes were raised in Randomized Complete Block with 3 replications under 3 production systems. For the sowing of inorganic trial NPK was applied @20:40:20 kg/ha at the time of sowing. For organic sowing Vermicompost (VC) was applied @5tonns/ha whereas for Zero Budget Natural Farming sowing *Ghanajeevamrit* (A paste was prepared by using 100 kg mixture of local cow, buffalo and goat dung, 1 kg Jaggery, 2 kg of pulse flour, handful of soil from bund of farm and 5 liters of cow urine. The paste was allowed to ferment for 48 hrs in shade. The fermented paste was then dried under sun light with stirring using a wood stick to form fine particles) was applied as basal dose@ 40kg/ha along with the spray of 10 % concentration of *Jeevamrit* (Fresh local cow dung (10 kg), aged cow urine (10 litres), Jaggery (2 kg), pulse flour (2 kg) and a handful of soil from the bund of farm were added in a barrel containing 200 liters of water and stirred in clockwise direction). In the Zero Budget sowing *Jeevamrit* spray was done at the interval of 15-days till the physiological maturity of the crop. The sowing was done on 30th May, 2018. The plot size was 6m×30cm×2. Five randomly selected plants in each plot were tagged for recording observations on plant height (cm), number of branches per plant, pods per plant, pod length (cm) and seeds per pod.

Analysis of data: The data were analyzed by using Two-*way* ANOVA.

Results and Discussion

Significant differences in the plant height, number of branches, pods per plant, seeds per pod and seed yield were obtained in genotypes and different production systems (inorganic, organic and Zero Budget Natural Farming), whereas no significant difference were obtained in pod length. Averaged mean of adzuki bean genotypes grown under Zero Budget Natural Farming production system was higher followed by organic production system as compared to inorganic production method in plant height, number of branches per plant, pods per plant, pod length and seed yield whereas showed lowest value for seeds per pod. Verma *et al*. (2018) similarly conducted an experiment and reported that the yield obtained under Zero Budget Natural Farming was comparable to that in conventional farming. Simultaneously interaction effect was significant on plant height and seed yield whereas, there were no significant interaction obtained for number of branches per plant, pods per plant, seeds per pod and pod length.

Plant height: The data on effect of different production systems on plant height in different adzuki bean genotypes is presented in Table 1. Under inorganic production system, genotype ADHP- 10 recorded significantly highest plant height content as compared to other genotypes. Genotype EC-340286 recorded significantly lowest plant height. The adzuki bean genotypes grown under organic conditions varied in range of 1.80 to 3.60 cm.

Number of branches per plant: Effect of production system on number of branches per plant in adzuki bean genotypes is depicted in Table 1. It showed that in inorganic production system highest value recorded in genotype ADHP-10 (3.80) and lowest in genotype EC-340286 (1.40). The genotypes grown under organic production system recorded maximum value in genotype ADHP-2 (3.60) and minimum value in genotype LOCAL TOTRU (1.80). In Zero Budget Natural Farming highest value found in genotype ADHP-2 (4.40) and lowest value in genotype HPU-51 (2.00).

Pods per plant: Effect of production system on pods per plant in adzuki bean genotypes is shown in Table 2. It revealed that under inorganic production system pods per plant ranged from (17.40-33.00 cm), lowest obtained in genotype HPU-51and highest value in genotype ADHP-1. In organic production system highest value found in ADHP-1(45.60 cm) lowest value in genotype LOCAL TOTRU (21.80 cm) whereas in Zero Budget Natural Farming highest value found in ADHP-7 (72.00 cm) and lowest in genotype EC-340286 (25.20 cm).

Pod length: Effect of production system on pod length in adzuki bean genotypes is depicted in Table 2. In inorganic production system highest pod length was shown in genotype ADHP-1 (9.38 cm) and lowest in genotype ADPH -10 (6.68 cm). In organic grown genotypes highest value of pod length found in genotypes ADPH -1 and ADPH – 2 (9.48 cm) and lowest value shown in genotype EC-030270 (6.54 cm). However, in Zero Budget Natural Farming grown genotypes highest value was exhibited in genotype ADHP-1 (9.78 cm) and lowest in genotype ADHP-4 (6.90 cm).

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

Genotypes	Plant height (cm) Production System				Number of branches per plant Production System			
	Inorganic	Organic	ZBNF*	Mean	Inorganic	Organic	ZBNF*	Mean
ADHP-1	129.08	121.80	148.38	133.09	3.60	3.20	3.00	3.27
ADHP-2	120.80	143.40	130.46	131.55	2.40	3.60	4.40	3.47
ADHP-3	115.00	122.68	139.64	125.77	2.60	3.40	3.20	3.07
ADHP-4	114.20	162.60	126.40	134.40	2.40	2.20	3.40	2.67
ADHP-5	99.80	126.90	152.36	126.35	2.60	3.00	2.20	2.60
ADHP-6	117.60	121.00	146.46	128.35	2.20	3.00	4.20	3.13
ADHP-7	99.60	140.60	155.90	132.03	2.00	2.80	2.60	2.47
ADHP-8	88.20	136.40	168.80	131.13	2.20	2.60	3.00	2.60
ADHP-9	90.20	123.20	97.36	103.59	2.40	2.60	2.60	2.53
ADHP-10	88.86	108.20	123.30	106.79	3.80	2.20	3.40	3.13
EC-340245	147.98	125.20	167.60	146.93	2.00	2.40	3.20	2.53
EC-030270	129.06	139.40	119.40	129.29	2.20	2.40	2.80	2.47
EC-340286	118.88	122.64	99.10	113.54	1.40	2.40	2.60	2.13
LOCAL TOTRU	113.02	103.38	173.80	130.07	2.20	1.80	2.20	2.07
HPU-51	89.38	137.20	156.00	127.53	1.60	2.20	2.00	1.93
MEAN	110.777	128.973	140.331		2.37	2.65	2.99	
For comparison of Means 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

* Zero Budget 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) Production System				Pod length Production System			
	Inorganic	Organic	ZBNF*	Mean	Inorganic	Organic	ZBNF*	Mean
ADHP-1	33.00	45.60	43.20	40.60	9.38	9.48	9.78	9.55
ADHP-2	21.40	39.40	50.40	37.07	8.34	9.48	8.58	8.80
ADHP-3	29.60	38.80	35.20	34.53	8.22	8.18	8.22	8.21
ADHP-4	19.80	28.80	37.00	28.53	7.36	8.12	6.96	7.48
ADHP-5	24.20	44.00	45.00	37.73	8.40	8.50	8.42	8.44
ADHP-6	29.20	39.60	36.20	35.00	8.76	8.62	9.26	8.88
ADHP-7	23.20	37.00	72.00	44.07	8.34	7.50	8.68	8.17
ADHP-8	18.20	39.80	37.20	31.73	8.94	8.84	7.82	8.53
ADHP-9	21.60	29.80	33.80	28.40	8.50	7.64	8.56	8.23
ADHP-10	23.80	28.00	35.80	29.20	6.68	7.64	8.20	7.51
EC-340245	29.80	31.80	44.00	35.20	8.24	8.48	7.86	8.19
EC-030270	28.20	26.00	37.00	30.40	8.98	6.54	7.92	7.81
EC-340286	23.60	36.20	25.20	28.33	8.32	7.84	8.16	8.11
LOCAL TOTRU	21.60	21.80	35.40	26.27	9.28	5.72	6.90	7.30
HPU-51	17.40	30.80	32.60	26.93	8.76	7.82	8.30	8.29
MEAN	24.31	34.49	40.00		8.43	8.02	8.24	
For comparison of Means C D (P=0.05)								
Genotypes	Production System		Interaction		Genotypes	Production System		Interaction
11.071	4.951		N/A		N/A	N/A		N/A

* Zero Budget Natural Farming

Seeds per pod: Effect of production system on seeds per pod in adzuki bean genotypes is shown in Table 3. In inorganic production system highest value of seed per pod was found in genotype LOCAL TOTRU (9.40) and lowest found in genotype ADHP-10 (7.00). Under organic production system highest value of seed per pod was observed in genotype ADHP-1 (8.80) and lowest value found in genotype EC-030270 (6.00). However, in Zero Budget Natural Farming grown genotypes highest value was shown by genotypes ADHP-1 and ADHP-6 (8.60) and lowest value found in genotype LOCAL TOTRU (6.60).

Seed Yield: The data on effect of different production systems on seed yield (kg/ha) in different adzuki bean genotypes is presented in Table 3. Under the inorganic production system highest value of seed yield exhibited in genotype ADHP-8 (368.1 kg/ha) and lowest value found in genotypes ADHP-7 and EC-340286 (138.9 kg/ha). In organic production system maximum value found in genotype ADHP-2 (1416.7 kg/ha) and minimum value found in genotype LOCAL TOTRU (138.9 kg/ha). However, in Zero Budget Natural Farming highest value shown in genotype ADHP-7 (2152.8 kg/ha) and lowest value found in genotype ADHP-10 (97.2kg/ha). The seed yield increases in Zero Budget Natural Farming may be attributed to promotion of microbial activity in soil by providing the nutrients and act as catalytic agent Verma *et al*. (2018).

Conclusion

On the basis of the results of this study found that Zero Budget Natural Farming fertilizers increases physical parameters which resulted in higher plant height, number of branches per plant, pods per plant and seed yield of adzuki bean genotypes. In Zero Budget Natural Farming the genotype(s) LOCAL TOTRU in plant height; ADHP-2 in number of branches per plant; ADHP-7 in pods per plant; ADHP-1 in pod length**;** ADHP-1& ADHP-6 in seed per pod and ADHP-7 in seed yield were emerged promising over the rest**.** Averaged mean of adzuki bean genotypes grown under three production system for seed yield revealed that genotypes ADHP-7, ADHP-8 and ADHP-9 in seed yield were adjudged superior over the rest.

Table 3. Effect of production system on seeds per pod and seed yield (kg/ha) in adzuki bean genotypes

Genotypes	Seeds per pod Production System				Seed yield (kg/ha) Production System			
	Inorganic	Organic	ZBNF*	Mean	Inorganic	Organic	ZBNF*	Mean
ADHP-1	8.40	8.80	8.60	8.60	208.3	833.3	1166.7	736.1
ADHP-2	8.60	8.40	7.80	8.27	333.3	1416.7	486.1	745.4
ADHP-3	7.80	7.40	7.80	7.67	222.2	875.0	444.4	513.9
ADHP-4	7.20	6.80	6.80	6.93	222.2	666.7	375.0	421.3
ADHP-5	7.80	7.80	8.00	7.87	277.8	597.2	708.3	527.8
ADHP-6	8.60	8.00	8.60	8.40	333.3	736.1	916.7	662.0
ADHP-7	7.80	6.60	7.80	7.40	138.9	888.9	2152.8	1060.2
ADHP-8	8.40	8.40	7.80	8.20	361.1	1375.0	930.6	888.9
ADHP-9	7.80	7.40	8.20	7.80	305.6	611.1	1638.9	851.9
ADHP-10	7.00	6.80	7.80	7.20	222.2	597.2	97.2	305.6
EC-340245	8.40	8.00	7.00	7.80	222.2	527.8	625.0	458.3
EC-030270	9.00	6.00	7.60	7.53	250.0	375.0	777.8	467.6
EC-340286	8.20	7.60	7.40	7.73	138.9	361.1	291.7	263.9
LOCAL TOTRU	9.40	5.20	6.60	7.07	305.6	138.9	805.6	416.7
HPU-51	8.60	7.20	7.20	7.67	222.2	652.8	180.6	351.9
MEAN	8.20	7.36	7.67		250.9	710.2	773.2	
For comparison of Means CD (P=0.05)								
Genotypes	Production System		Interaction		Genotypes	Production System		Interaction
1.009	0.451		N/A		15.978	7.146		27.675

* Zero Budget Natural Farming

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