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Assessment of Quantitative Variation of Rajma Bean Genotypes for Yield and Yield Attributing Traits in Multi-Environments of Nepal

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Abstract- Rajma (Phaseolus vulgaris L) known as the common bean, French bean, kidney bean, bush bean, and pole bean is the most important grain legume of Nepal which covers about 10,529 ha areas along with the productivity of 1477 kgha-1. Generally it is grown during summer in mid/high hills and during winter (post rainy) season in terai/inner terai in rice and maize based eco-system. Now Rajma bean is being popular as the cash crop in the province 3, 5 and 6 because of producing organic products and tastier quality. Multi-environment trials was carried out at Nepalgunj, Parwanipur, Itahari and Surkhet during the winter season of 2014-2017 comprised of 10 diverse Rajma genotypes in Randomized Complete Block Design with three replications in order to evaluate the quantitative variation with respect to yield and yield contributing traits.

Keywords: *component traits, environments rajma bean, quantitative, variation.*

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Assessment of Quantitative Variation of Rajma Bean Genotypes for Yield and Yield Attributing Traits in Multi-Environments of Nepal

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Abstract- Rajma (Phaseolus vulgaris L) known as the common bean, French bean, kidney bean, bush bean, and pole bean is the most important grain legume of Nepal which covers about 10,529 ha areas along with the productivity of 1477 kgha-1. Generally it is grown during summer in mid/high hills and during winter (post rainy) season in terai/inner terai in rice and maize based eco-system. Now Rajma bean is being popular as the cash crop in the province 3, 5 and 6 because of producing organic products and tastier quality. Multi-environment trials was carried out at Nepalgunj, Parwanipur, Itahari and Surkhet during the winter season of 2014-2017 comprised of 10 diverse Rajma genotypes in Randomized Complete Block Design with three replications in order to evaluate the quantitative variation with respect to yield and yield contributing traits. The combined analysis of variance showed that the highly significant differences among the genotypes and locations in the traits like days to flowering, days to maturity, plant height, hundred seed weight and grain yield. However; there was not any GxE interaction effect found in days to flowering, days to maturity and grain yield. Mean yield performances showed that the genotype PDR-14 (2341 kg ha-1) produced the highest yield followed by Utkarsh (2332 kg ha-1) and Arun-2(2021 kg ha-1). In conclusion, PDR-14 gave 9-56% higher yield among the genotypes and its stability analysis test also indicated that PDR-14 was found a highly stable across the environments and over the years. Variegated red kidney shape seed, white flowers along with dwarf and glabrous leaf pubescence is the DUS trait of the PDR-14 and recommended for terai/inner terai to high hills.

Keywords: component traits, environments rajma bean, quantitative, variation.

I. Introduction

Rajma is an important legume known as Common bean, French bean, Kidney bean, bush bean, and pole bean. In many developing countries, common bean (*Phaseolus vulgaris* L.) are being grown for vegetables and pulses in diverse cropping system. The common bean is a self-pollinated species belonging to the Fabaceae family and is the most important sources of the protein (Broughton et al. 2003). A high number of small land holding farmers with low incomes usually adopted to produce the crop. In Nepal, it is cultivated an areas of about 10,529 ha with the productivity 1477 kg/ha and being popular as the cash crop in the Gandaki province, province 5 and Karnali province. It grows as a summer crop in mid/high hills & winter crop in terai/inner terai. The high genetic diversity found in African, Asian and European germplasm has suggested the possibility that those continents could be considered as other centers of genetic diversity for common bean (Ocampo et al. 2005; and Sharma et al. 2014). It is an important legume crop cultivated in a wide range of agro-climatic conditions from Tarai (91m amsl) to high hill (2500m amsl) of Nepal, especially in mountain districts such as Jumla, Humla, Mustang, Rasuwa, Solukhumbu, etc, where mixed landraces with varying morphologies are cultivated. Nepal's hills and mountains are rich in bean diversity, and some landraces have unique characteristics (KC et al 2016, Joshi et al 2017a). In general, common beans grown in high-hill have better taste and are considered more nutritious compared to the beans grown in Terai region of Nepal. More recently, this crop is commonly grown along with kidney bean, fetches good return and have well established market (Neupane et al 2008, Muchui et al 2008, Shrestha et al 2011, Neupane and Vaidya 2002). In these days, area of phaseols bean is in increasing trends due to its good market potential along with good returns. This bean is being popular in Jumla and periphery districts of Karnali province known as Jumla's organic bean gift(Jumla ko Kosheli) in the Nepalgunj and Kathmadu big marts. The main objective of the study was in order to evaluate the quantitative variation with respect to yield and yield contributing traits. In terai region of Nepal, Rajma has been cultivating in winter season. Till date, there is not anyone Rajma variety released/registered for the farmers cultivation. One of the mandated organizations for legumes research, GLRP, Khajura has prepared the variety development program in collaboration with NARC satellite stations.

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II. Materials and Methods

In Coordinated Varietal Trial (CVT); A total of 10 genotypes namely PDR-14, Amber, Utkarsha, Arun-2, BL-63, Kanpur, Chitra NL-1, Pant-1 and Pant-2 were evaluated in 2015 at RARS, Parwanipur and GLRP, Khajura, in 2016 at JRP, Ithari; GLRP, Khajura; ARS, Surkhet and RARS, Parwanipur, same as in 2017 at GLRP, Khajura. Trial was conducted in Randomized Completely Block Design in $4\times3.6 = 14.4$ m^2 plot size with three replications. The plant geometry, row-to-row space was maintained as 40 cm and plant to plant 10 cm. Recommended dose of fertilizer 100:60:40 kg NPK/ha was applied , full dose of phosphorus and potash and half dose of nitrogen applied during field preparation and remaining half dose of nitrogen was top dressed after 20-30 days after sowing. During the intervention period, precision agronomic packages were followed and appropriate pesticides and insecticides were applied as per the requirements. Data on agro-morphological traits, yield and yield components were collected and data was analyzed using META-R and R-Stat Version 3.2.

III. Results

At Parwanipur, 2015, the results of analysis of variance showed statistically highly significant differences among the genotypes in the agronomic traits days to 50% flowering, days to maturity, plant height, grain yield and 100 seed weight. Genotypes Arun 2(11500 kg/ha) and Utkars (1079 kg/ha) were produced better yield among the tested genotypes in Table 1. Likely in khajura, the results of analysis of variance (Table 2) revealed that genotypes were statistically significant differences in the parameters like plant height, seed per pod and hundred seed weight. Genotype NL1 (563 kg/ha), and Arun-2(542 kg/ha) were produced the highest yield among tested genotypes. NL-1 had a bolder seed (38 g/100 seed). In 2016, at GLRP, Khajura data (Table 3) revealed that the genotypes were highly significant in days to maturity, plant height, and seed weight. Genotype Utkarsh produced the highest yield (2600 kg/ha) followed by, PDR-14 (2471 kg/ha) and Pant-1 (1983 kg/ha). Arun-2 showed the highest seed weight (47 g/100 seed). Same as in 2016, JRP, Ithari data showed that the genotypes were highly significant in days to 50% flowering, days to maturity and plant height and significant in grain yield. Genotype Utkarsh produced the highest yield (1625 kg/ha) followed by, PDR-14 (1412 kg/ha) in Table 4. Data (Table 5) illustrated that genotypes were statistically significant difference in the parameters like days to maturity, plant height, and hundred seed weight. Genotype Amber (3146 kg/ha) produced the highest yield followed by Arun-2(3090 kg/ha) and Utkarsh (2986 kg/ha). Arun-2 had a bolder seed (44 g/100 seed). In 2016, RARS, Parwanipur data analysis of variance showed that the genotypes were highly significant difference in days to flowering, days to maturity, plant height, grain yield and seed weight. Genotype Utkarsh produced the highest yield (1538 kg/ha) followed by, PDR-14 (1369 kg/ha) and Amber (1256 kg/ha). Same as previous Arun-2 had the highest seed weight (52 g/100 seed) in Table 6. Likely in the year of 2017, GLRP, Khajura data analysis of variance revealed that the genotypes were significantly difference(<0.005) in days to 50% flowering, days to maturity, plant height, seed per pod and yield kg/ha. Genotype PDR-14 produced the highest yield (2319 kg/ha) followed by, Utkarsh (1992 kg/ha) and BL-63 (1878 kg/ha) in Table 7. Combined mean analysis of variance showed that genotypes were significantly different in days to maturity, plant height and yield parameters across the locations over the years (2015-2017).

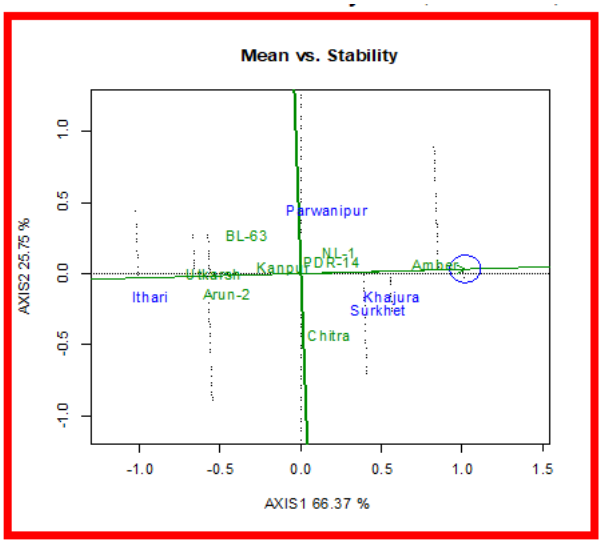

Fig. 1: Genotypes mean vs. stability

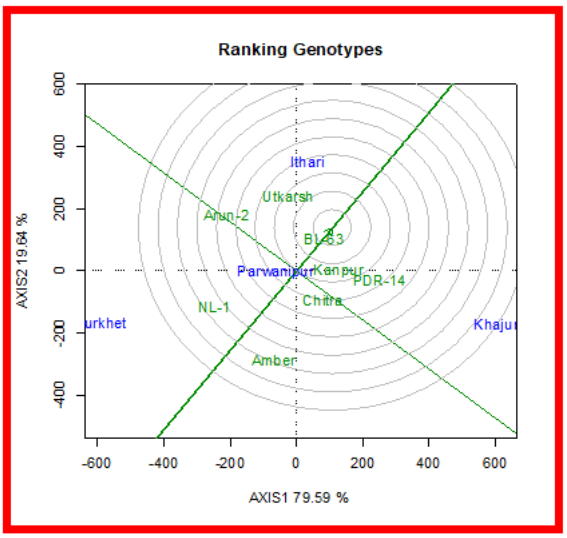

Fig. 2: Ranking of genotypes based on genotype performance and stability

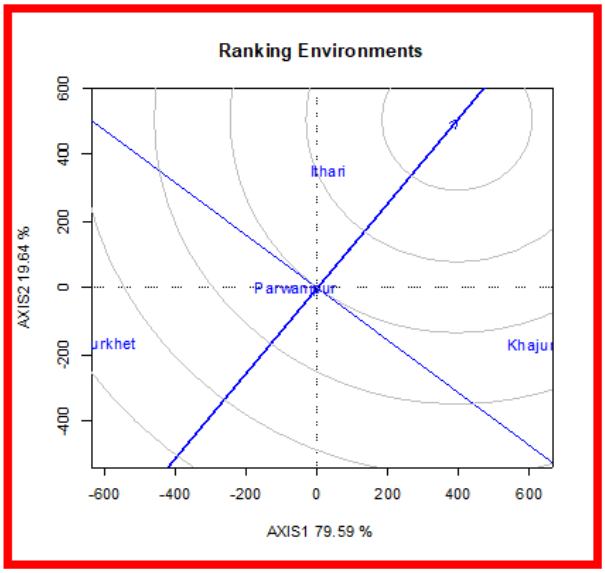

Fig. 3: Ranking of genotypes based on discriminating

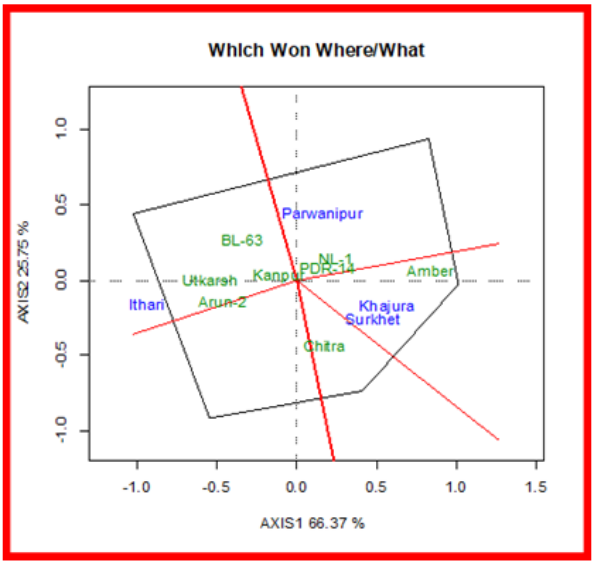

Fig. 4: Genotypes with specific environment and representa -tiveness of the average environment

G x E interaction in GGE biplots in figure 1 illustrated that based on both mean and stability the best genotype was Amber then followed by PDR-14. In figure 2 base on concentric ring the ideal genotype was BL-63 however according to figure 3 Ithari was seen the best environment. In figure 4, genotype Amber and Chitra were found ideal and vertex to Khanjra and Surkhet environments, while NL-1 and PDR-14 were ideal for Parwanipur and BL-63, Utkarsh, Kanpur-1 and Arun 2 were found ideal for Ithari environment.

IV. Discussion

Beans are consumed as whole seeds as vegetable or split forms, both as soup or 'daal'. Beans contains healthy proteins, are consumed by all households. Indeed, black bean soup is given to their sick people as an energy supplement. Farmers in Nepal preferred bean landraces that are medium growth habit, early maturing nature, high yielding, good seed size and color and are high demand in the market (Chhetri and Bhatta 2017, Neupane et al 2008). A similar study was done in bean growing area in Malawi to understand the farmer's specifications for variety selection showed that farmers looked on grain color, cooking time, taste, grain size as well as grain brightness to choose the varieties (Chirwa and Phiri 2005). Stoilova et al. (2006) found that out of many accessions studied, some accessions with an erect habit, a shorter period to reach maturity had

higher number of pods and seeds per plant as these genotypes escaped unfavorable conditions of high daily temperature and low humidity during the flowering and pod formation periods. In the study, the genotypes had different flowering and pod maturity times even they were planted on the same date. Flowering and pod maturity occurred earliest for all the varieties in the khajura and surkhet than Itahari and Parwanipur site. This flowering data clearly indicated the environment particularly the temperature played an important role in physiological and phenological growth of the varieties included in the study. Similar results of common bean landraces at Mexico showed there were significant differences in the morphological and physiological traits of the plant, pod and grain among different geographic regions which were also associated with different indigenous groups (Chavez-Servia et al 2016). There was effect of genotype by environment interaction on the bean genotypes and yield traits. Some lines showed vertex that mean they were location specific while some lines were highly stable across the locations.

V. Conclusion

The combined ANOVA showed that the highly significant differences among the genotypes and locations in the quantitative traits like Days to 50% flower, Days to maturity, Plant height, Hundred seed weight and grain yield. However the effect of GxE interaction was not found in Days to 50% flower, Days to maturity and Grain yield. Overall mean performances in terms of grain yield over the years and across the location showed that the genotype PDR-14 (1862 kg ha-1) produced the highest yield followed by Utkarsh (1698 kg ha-1) and Amber (1666 kg ha-1). Genotype PDR-14 gave 12-35% higher yield among the genotypes and its stability analysis test also indicated that PDR-14 was found a highly stable across the environments and over the years. Variegated red kidney shape seed, white flowers along with dwarf and glabrous leaf pubescence is the distinctness, uniformity and stability (DUS) testing trait of the PDR-14 and recommended for terai/inner terai to high hills.

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Table 1: Performance of Rajma genotypes in MLT at RARS, Parwanipur, 2015

S. No.	Genotypes	DF	DM	PLHT(cm)	PP	SP	GY (Kg/ha)	HSWT(g)
1	PDR 14	54b	112b	30c	11	3	966.0abcd	39.8a
2	Amber	50c	109c	29c	11	4	855.3cd	35.6cd
3	Utkars	64a	115a	46a	13	4	1079.3ab	29.3e
4	Arun -2	54b	112b	42ab	12	4	1150.0a	39.1a
5	BI- 63	50c	109c	26c	10	3	888.0bcd	36.9bc
6	Kanpur	54b	112b	39b	11	4	769.3d	35.1d
7	Chitra	50c	109c	25c	11	4	892.7bcd	36.6bcd
8	NI-1	50c	109c	26c	44	4	1026.7abc	38.1ab
	Mean	53.5	110.8	33.04	15	4	953.4	36.3
	P-value	0.000**	0.000**	0.000**	0.48	0.55	0.039*	0.000**
	F Value	0	99.6	26.93	1	1	3.0	33.9
	CV%	0	0.38	8.34	132	6	13.3	2.6
	LSD	0.00	0.75	4.82			222.1	1.70

Table 2: Mean data on phenology growth and Yield of MLT, GLRP, Khajura, 2015

S.No.	Genotypes	PLHT (cm)	PP	SP	GY (Kg/ha)	HSWT(g)
1	PDR 14	37	7	4	518	33
2	Amber	35	7	3	425	35
3	Utkars	39	6	5	465	30
4	Arun -2	48	7	5	542	35
5	BI- 63	33	7	4	515	33
6	kanpur	36	7	4	437	34
7	Chitra	36	6	4	430	36
8	NI-1	43	8	3	563	38
	Mean	38	7	4	487	34
	P value	0.00	1	0 .00	1.0	0 .00
	F Value	0.98	0.7	2	0.16	1.2
	CV%	21.6	18.4	16.31	18.49	10.15

Table 3: Mean data on phenology, growth and yield of MLT, GLRP, Khajura, 2016

S. No.	Genotypes	DF	DM	PLHT	PP	SP	HSWT(g)	GY (Kg/ha)
1	PDR-14	46	108	47	37	3.5	42	2471
2	Amber	45	112	4	12	4.1	40	1938
3	Utkarsh	46	112	55	11	3.5	37	2600
4	Arun-2	52	110	70	10	3.6	47	1579
5	BL-63	44	105	44	10	3.6	41	1517
6	Kanpur	45	110	46	11	4.3	40	1783
7	Chitra	44	100	39	10	3.2	39	1358
8	NL-1	43	95	44	10	3.3	41	1842
9	Pant-1	45	110	74	10	3.9	42	1983
	Mean	46	107	51.7	13	3.7	41	1897
	P-Value	0.4	<.001	<.001	0.46	0.181	0.002	0.05
	CV%	10.27	1.1	10	116.6	13	4.8	23.9
	LSD	NS	2.1**	8.9**	NS	NS	3.4**	*

Table 4: Mean data on phenology and growth and Yield of MLT, JRP, Itahari, 2016

S. No.	Genotypes	DF	DM	PLHT	PP	SP	GY (Kg/ha)
1	PDR-14	76	122	31	15	4	1412
2	Amber	75	122	31	17	4	1121
3	Utkarsh	82	121	33	16	4	1625
4	Arun-2	76	119	30	15	4	1396
5	BL-63	75	103	22	12	4	1046
6	Kanpur	75	109	30	11	4	892
7	Chitra	76	103	22	9	4	975
8	NL-1	75	105	23	12	4	896
	Mean	76	113	28	13	4	1170
	P-Value	<.001**	<0.001**	<.001**	0.08	0.44	0.03*
	CV%	1.3	0.8	8.3	25.5	9.6	23.1
	LSD	1.8**	1.5**	4.0**	NS	NS	473.6*

Table 5: Mean data on phenology growth and Yield of MLT, ARS, Surkhet, 2016

S. No.	Genotypes	DTF	DTM	PH	PPP	HGW	GY (Kg/ha)
1	PDR-14	47	114	48	22	40	2701
2	Amber	44	122	50	21	40	3146
3	Utkarsh	57	123	124	18	33	2986
4	Arun-2	46	121	106	20	44	3090
5	BL-63	46	110	36	17	39	2417
6	Kanpur	47	120	45	16	40	2319
7	Chitra	44	111	46	15	40	2583
8	NL-1	42	108	45	14	39	2970
	Mean	46	116	63	18	40	2777
	P-Value	<.001**	0.05	<.001**	0.36	0.018*	0.05
	CV%	4.4	5.4	15.5	25	6.8	13.3
	LSD	3.6	NS	17.0	NS	4.7	NS

Table 6: Mean data on phenology growth and Yield of MLT, RARS, Parwanipur, 2016

S. No.	Genotypes	DF	DTM	PH	PPP	SPP	HSWT (g)	GY (Kg/ha)
1	PDR-14	54	117	36	15	6	50	1369
2	Amber	54	121	32	19	6	44	1256
3	Utkarsh	62	121	75	14	7	48	1538
4	Arun-2	52	118	68	14	7	52	1070
5	BL-63	55	115	33	14	7	43	1015
6	Kanpur	57	116	40	11	7	46	828
7	Chitra	52	115	33	12	7	42	789
8	NL-1	54	114	34	15	6	42	868
	Mean	55	117	44	14	7	46	1092
	P-Value	0.001	<.001	<.001	0.11	0.58	<.001	0.006
	CV%	3.8	1	13.3	20.4	10.5	0.8	19.8
	LSD	3.7**	2.0**	10.3**	NS	NS	3.2**	378.9*

Table 7: Performance of Rajma Genotype in MLT GLRP, Khajura 2017

EN	Genotypes	DF	DM	PIht	PP	SP	GY
1	PDR 14	40	104	20	11	4	2319
2	Amber	40	107	13	14	5	1329
3	Utkarsh	54	106	21	10	5	1992
4	Arun-2	36	103	27	9	4	1722
5	BL63	35	90	16	12	5	1878
6	Kanpur	34	104	13	8	5	822
7	Chitra	34	91	14	10	5	1715
8	NL-1	34	89	15	11	4	1503
9	Pant-1	40	107	27	11	5	1725
10	Pant-2	35	99	19	8	5	1430
	Mean	38	100	19	10	5	1644
	P-value	<0.001	<0.001	<0.001	0.300	<0.001	0.025
	CV%	3.13	2.33	17.45	26.34	6.55	25.14
	LSD	2.05	3.99	5.55	4.71	0.53	708.86

Table 8: Combined analysis Rajma MLT across the location over the years (2015-2017)

S. No.	Genotypes	DF	DM	PLHT	PP	SP	HSWT(g)	GY(Kg/ha)
1	PDR-14	58	119	39	18	4	43	1862a
2	Arun-2	60	119	46	16	4	44	1433ab
3	Chitra	59	116	36	14	4	39	1478abc
4	Amber	58	121	37	17	4	41	1666bcd
5	BL-63	53	116	30	14	4	40	1300bcd
6	NL-1	52	111	31	16	4	35	1202d
7	Kanpur	63	121	42	19	4	40	1250cd
8	Utkarsh	62	120	37	14	4	40	1698
	Mean	59	118	37	17	4	40	1474
	P-value							
	Env	<0.001	<0.001	<0.001	0.500	0.100	<0.001	<0.001
	Gen	0.260	0.020	0.004	0.500	0.420	0.001	0.018
	Year	0.190	0.020	<0.001	0.120	0.300	<0.001	<0.001
	G X E	0.990	0.120	0.900	0.330	0.700	0.600	0.99
	CV %	13.00	5.2	27	31	11	12	31
	LSD							416.77