Short communication

Cultivar mixtures in bean reduced disease infection and increased grain yield under mountain environment of Nepal

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Abstract
Field experiment on cultivar mixture was conducted for trailing type and bushy type bean (*Phaseolusvulgaris* L.) to know the effect of cultivar mixtures on grain yield and disease infection during summer season 2015 in Jumla. The result of the study revealed that agronomic attributes were enhanced while *Anthracnose* infection was reduced under cultivar mixtures of bean than those of their sole cropping both for trailing type and bushy type beans under study.
Key words: cultivar mixture, trailing bean, bushy bean, sole cropping, grain yield, agronomic attributes and, disease infection

Introduction

Bean (*Phaseolus vulgaris* L) was cultivated in 2250 ha of the land in Jumla district (ARS Jumla, 2014). Beans popularly gown in Jumla is called *Jumli Simi/Rajma*. The crop is a highly diversified and indigenous crop to Jumla and whole of Karnali zone. Earlier it was usually grown in virgin, marginal land and all type of upland. After realizing the nutritive value, market price and availability of high yielding genotypes, farmers have started to grow bean in cropping system of wheat-bean in low land too. Beans are generally consumed as dual purpose such as in the form of pulse and vegetables. Local germplasm have high variation in color, shape, size of seed and growth habit (trailing & bushy types) of plant. It is one of the important high value and cash crops such as apple, potato and walnut of Jumla and exportable commodity to outside as well. Bean cultivation have been using for growing the crop by the farmers of this district both in mono and mixture culture based on its color, shape and size of seed and growth habit. Even not a single cultivar of the crop has been released yet, however, bean genotype of KBL-3 and PB-0001 have been identified as high yielding i.e. 3017 Kg/ha and 2749 Kg/ha, respectively (ARS Jumla, 2014). These genotypes could be released as a new variety in near future for the general cultivation under high hill environment of the country. Because of these reasons in Jumla farmers use only local cultivars either in mono or mixed cultivation. Bean is an important cash crop in Jumla and adjoining high hill districts and Mustang where mixture of landraces with different size and seed coat are harvested and sold in the market (Shrestha *et al*; 2011). Common bean is an important source of dietary protein and starch in Africa and a primary staple in parts of the Great Lakes Region (Hillocks *et al;* 2006).

Variety mixture or multiline culture can improve significantly the control of disease that has an air-borne dispersal phase, (rusts, mildews, *Septorioses, Helminthosporioses, Rhynchosporium* and even *Pseudocercosporella, Herpotichoides*), often to the extent that the use of fungicide becomes uneconomic. Because of this and other interactions among the components, mix culture provides a buffer against environmental variation so that yield is stable among environment. It is clear that variety mixture can be used successfully on a large scale but to do so it requires more publicity and information on the potential value and advantages of mix culture of bean for individual farmers together with incentives related to the benefits for the environment as a whole. Variety mixtures can be produced commercially at low cost to control disease and provide yield stability of the crops. If there is a host diversity effect, it will tend toward reduced disease in mixtures compared with single genotype populations, but increased disease is predicted in some circumstances (Garrett and Mundt, 1999) as well. If genetic uniformity makes a crop more vulnerable to disease then one potential low cost method of suppressing disease is to mix the seed of cultivars (i.e. plant genotypes) that vary in their susceptibility to specific pathogens (Castro, 2007).

In eastern Africa and the Great Lakes Region small holder farmers have local preference for growing beans in mixture of traditional landraces and modern variety which they understood to provide resistance to local pests and diseases, and to enhance yield stability (Kandi *et al*; 2015). The effectiveness of mixture to do so depends not only on disease resistance available but also on the nature and speed of the life cycles of the pathogens as well as their means of spread (Mulumba *et al;* 2012). The experiment was designed and conducted at ARS Vijayanagar, Jumla with the objective of reducing disease infection and raising bean yield of the crop.

Materials and methods

Two field experiment of common bean consisting of four cultivars of trailing types and three cultivars of bushy types were conducted at the Agricultural Research Station, Jumla (2390m) during summer season of 2015. Four trailing cultivars of bean were KBL-1, KBL-3, PB-0002 and PB-0048 whereas for bushy cultivars were PB-0001, KBL-5 and KBL-8. The experiments were in net plot size of 2-x3- m^2 per plot in a spacing of line to line 50cm and plant to plant 10cm to generate the preliminary information on cultivar mixture. Chemical fertilizers were applied @100:60:40; $N:P_2O_5:K_2O$ kg/ha in which 50% Nitrogen and full doze of Phosphorus and Potash were applied as basal application while remaining doze of nitrogen was top dressed after first weeding of the crop. Beans were planted on June 4^{th} 2015 and harvested on second week of November 2015. Bean cultivars of resistant, KBL-1, moderately resistant, KBL-3, susceptible, PB-0002, and highly susceptible PB-0048 while for bushy type resistance cultivar PB-0001, susceptible cultivar

KBL-5, and highly susceptible cultivarKBL-8 were purposely included in the experiment. Cultural operation such as weeding, drainage and staking were done as needed. Grain yield and yield attributing factors were recorded. *Anthracnose* is major disease of the crop which occurs every year in area where the experiment was conducted. It is one of the problems of the bean in Jumla area. *Anthracnose* disease was recorded at 0-9 scale in which"0"score indicates disease free whereas score "9"indicates highly susceptible. Harvested grain from the plot was sundried and converted into kg per hectare basis. Simple descriptive analysis was done with the help of Microsoft excel package.

Results and discussion

Among the tested trailing type bean in sole and mixed cropping revealed that the highest grain yield of 1773 kg/ha was obtained from the mixture of KBL-1+PB-0002+ PB-0048 followed by sole cropping of KBL-3 (1667 kg/ha) and mixture of KBL-1+KBL-3+PB-0048 (1587 kg/ha). Other entries in the experiment had lower grain yield than that of these entries (Table 1). For *Anthracnose* score among the tested entries, the highest score was 2 with moderately resistance. Disease prevalence in the experiment was not so severe probably due to low rainfall followed by unfavorable environment for the disease. Maturity of the entries was not found much affected obviously due to the combination of treatments under study. This could be because of moisture stress or other physiological attributes of the specific cultivars. Details of the agronomic traits of the trailing type bean cultivars have been illustrated (Table 1).

Table 1. Grain yield and yield attributing factors of trailing type bean as affected by genotypes and their combination in 2015 summer season at ARS, Jumla

SN	Genotype	Plant ht (cm)	Flowering days (DAS)	Maturity (DAS)	No. of plants/ m^2	No. of Pod/plant	No. of Seed/ pod	Pod length (cm)	100 seed Wt (g)	Seed Yield (Kg/ ha)	Anthracnose score (0-9 scale)
1.	PB-0002	68.2	40	86	32	10	4.5	8	38	1303	2
2.	PB-0048	42	36	86	29	8.5	5	7.5	40	1363	2
3.	KBL-1	52.2	35	87	28	11	4	7	22	1263	2
4.	KBL-3	59	38	93	29	15	5	6.5	28	**1667**	1
5.	PB-0002+PB-0048	59.5	38	88	32	9.5	4.5	8.5	36	1100	1
6.	KBL-1+PB-0002	48.2	36	89	31	7.5	4.5	7	30	1040	1
7.	KBL3+PB0002	26.2	37	93	32	6	4.5	6.5	32	740	1
8.	KBL-1+PB-0048	44.2	41	90	26	7	4.5	7	32	957	1
9.	PB-0048+KBL-3	30	42	93	18	6.5	4.5	6.5	30	1100	1
10.	KBL-1+KBL-3	46.5	43	90	37	7	4.5	6.5	28	1487	1
11.	KBL-1+PB-0002+PB-0048	59.5	41	92	**45**	6.5	4.5	7	32	**1773**	2
12.	KBL-3+PB-0002+PB0048	46.7	40	94	32	8.5	5	8	26	1337	1
13.	KBL-3+KBL-1+PB-0002	49.7	41	94	37	8.5	5	7	34	1270	1
14.	KBL-1+KBL-3+PB-0048	35.2	41	95	30	8.5	4.5	7.5	34	**1587**	1
15.	PB-0002+PB-0048+KBL-3+KBL-1	52.2	40	90	32	9.5	6	7.5	26	1270	1
Grand mean		48.0	39.3	90.7	31.3	8.6	4.7	7.2	31.2	1283.8	1.3
Standard deviation		11.5	2.4	3.0	5.9	2.3	0.5	0.6	4.8	275.1	0.5

Among the tested bushy type bean in sole and mixed cropping revealed that the highest grain yield of 1337 kg/ha was obtained from the sole cropping of PB-0001 followed by sole cropping of KBL-5 (1147 kg/ha) and KBL-8 (1o37 kg/ha). Other entries in the experiment had lower grain yield than that of these entries (Table2). Grain yield was not affected due to prevalence of the disease; however grain yield difference among the entries could be because of the varietal potentiality of the tested cultivars. For bushy types bean sole grain yield was higher than the mixture in the study. Statistically grain yield produced by the sole cropping of PB-0001 was the highest followed by sole cropping of KBL-5 among the tested entries while rest of the entries were at par with grain yield. Details of the agronomic traits of the bushy type bean cultivars have been illustrated (Table 2).

Table 2. Grain yield and yield attributing factors of bushy type bean as affected by genotypes and their combination in 2015 summer season at ARS, Jumla

SN	Genotype	Plant ht (cm)	Flowering days (DAS)	Maturity (DAS)	No. of plants/m^2	No. of Pod/plant	No. of Seed/pod	Pod length (cm)	100 seed Wt (g)	Seed Yield (Kg/ha)	Anthracnose score (0-9 scale)
1	PB-0001	39.7	43	88	30	9.5	6.5	6.5	42	**1337**	3
2	KBL-5	42.7	33	73	36	8.3	5.5	7	22	**1147**	3
3	KBL-8	39.5	34	78	31	7	5.5	7	42	**1037**	3
4	PB0001+KBL-5	40.2	44	84	27	8	6.5	8	28	970	2
5	KBL-8+PB-0001	34	38	86	25	7.5	5	6.5	40	983	2
6	KBL-5+KBL-8	38	35	75	26	8.5	5	7	38	950	1
7	PB-0001+KBL-5+KBL-8	40	35	85	28	9	5.8	7	34	993	1
Grand mean		39.2	37.4	81.3	29.0	8.3	5.7	7.0	35.1	1059.6	2.1
Standard deviation		2.7	4.4	5.9	3.7	0.9	0.6	0.5	7.6	138.7	0.9

It has been widely anticipated that for cultivars used in the mixture must possess similar agronomic characteristics and may be phenotypically similar for important traits including maturity, height, quality and grain type, depending on the agronomic practices and intended use of the crops (Castro, 2001). In a uniform crop there is an increase in genetic vulnerability to disease caused by microbial pathogens. For a sustainable farming like that of high hills of Nepal diseases are causing serious economic losses to mono cropping systems. Considering these factors in mind trailing and bush type bean were grown separately in the varietal mixture study. Cultivar mixtures generally do not completely suppress or eliminate the disease rather it reduce the rate of disease progress eliminating large numbers of spores at each cycle of pathogen multiplication. In the mixtures, the infection process may be slowed by the induction of defense responses in susceptible plants.

Varietal mixture of trailing type bean cultivars exhibited that higher grain yield and reduction in disease incidence was found for mixture combination compared to mono cropping under study in high hills of Jumla condition of Nepal in summer season. This could be explained from the fact that cultivar mixture of bean favors for intra specific competition resulting in higher grain yield and creating unfavorable condition for *Anthracnose* infection. This was supported by the findings of Mulimba *et al* (2012) in varietal diversity of banana in Uganda. However, in the study, sole cropping of KBL-3 trailing bean was equally good for grain yield as that of mixed culture of combinations of three cultivars. This could because of long trails of KBL-3 that might have harnessed high solar radiation and good competing ability compared to other short cultivars in the study (Table 1). Disease prevalence relationship was directly related with sole cropping

compared to cultivar mixture. Increase in grain yield was positively related with varietal mixture in the study (Fig. 1). This suggests that disease incidence is reduced in mixed cropping and grain yield is enhanced in the system. Plant diseases are one of important factors of reducing crops from achieving yield potential. The cost of disease and its prevention can dramatically affect the economics of crop production. This is the reason why in a varietal mixture of bean disease infection has been considered.

For bushy type bean cultivar mixture, sole cropping was superior to their mixed culture with respect to grain yield production whereas sole cropping has shown more prevalence of disease than that of mixed culture (Fig. 2). This finding exhibited that mixed cropping is favorable to reduce disease incidence. Study on plant disease epidemiology with respect to same genotype and mixtures of host genotypes were reported to offer promising options for deployment of resistance genes in agriculture (Garrett and Mundt, 1999). Our finding from the study for trailing and bushy type bean supports lower disease incidence in cultivar mixture compared to sole cropping of the cultivars undertaken. Disease incidence in the cultivar mixtures of snap beans (*Phaseolus vulgaris* L.) was reduced 30-60% (Castro, 2001). Varietal mixtures for both trailing and bushy type bean (*Phaseolous vulgaris* L.) in our study also revealed low incidence of disease against the their sole cropping as well. Seekendi *et al (*2015) also observed that there was low incidence of disease in mixed cropping compared to sole cropping of beans.

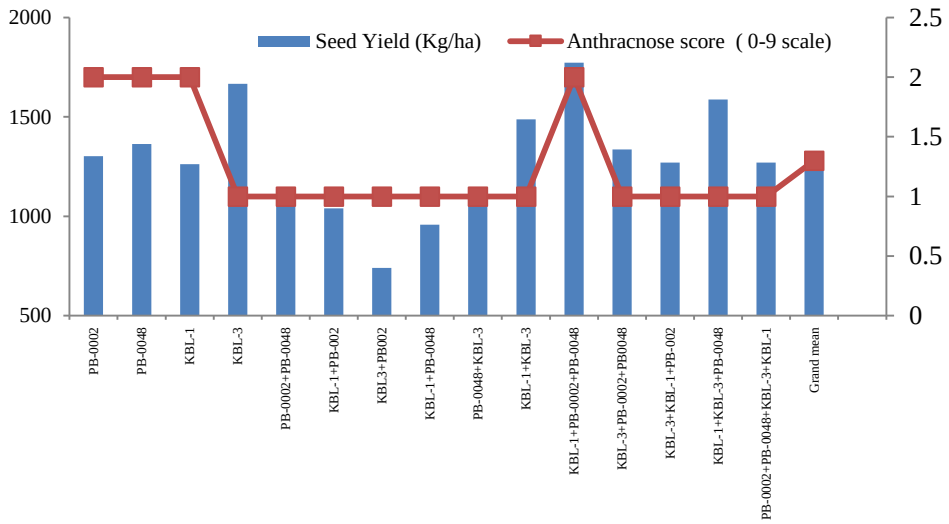

Fig. 1 Relationship between seed yield and Anthracnose score of trailing type bean mixture and sole crops in Jumla, 2015

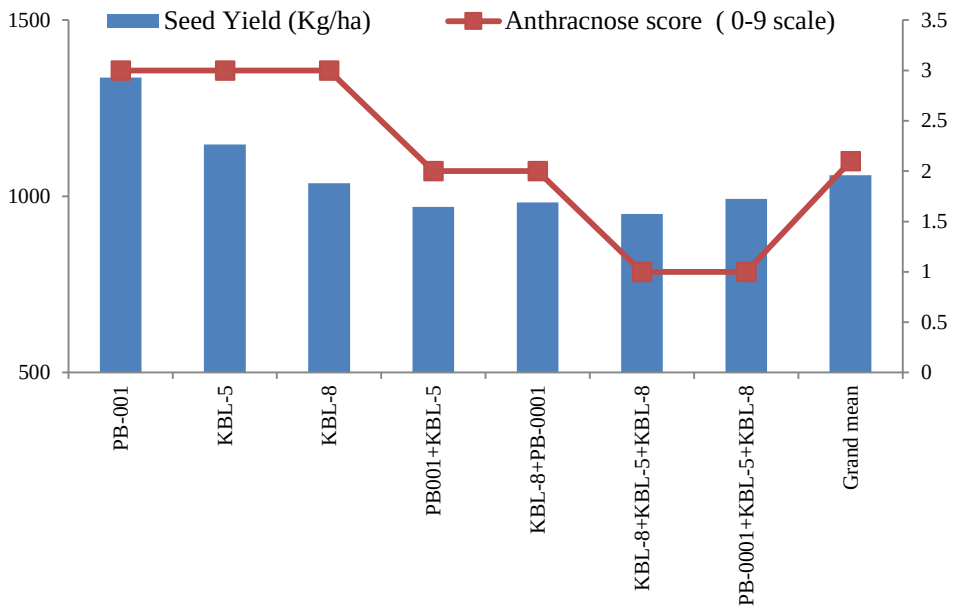

Fig. 2 Relationship between seed yield and Anthracnose score of bushy type bean mixture and sole crops in Jumla, 2015

Conclusion

Grain yield of bean in mixed culture was significantly higher than their sole cropping in trailing type beans while in mono culture for bushy type beans the disease infection was observed higher in sole cropping in both trailing and bushy type. The findings is of one season observation and for further confirmation multiyear observation on varietal mixture with respect to grain yield and yield components coupled with other important disease observation could give assured results to be extrapolated in similar agro-ecological domains across Nepal.

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