African Crop Science Conference Proceedings Vol. 8. pp. 2087-2090
Printed in El-Minia, Egypt
ISSN 1023-070X/2007$ 4.00

Resistance of nutrient-rich bean varieties to major biotic constraints in Kenya

I. N WAGARA[1] *& P.M KIMANI.*[2]
[1]Department of Biological Sciences, Egerton University, P.O BOX 536, Egerton, Kenya
[2]Department of Plant Science and Crop Protection, University of Nairobi, P.O BOX 29053, Nairobi, Kenya
E-mail: inwagara@yahoo.com, kimanipm@nbnet.co.ke

Abstract: Common bean, *Phaseolus vulgaris* L., is valued as a major source of affordable protein and minerals, and a source of income and employment for rural communities. It is an important staple in the diet of people of all income categories, with consumption levels in eastern and southern Africa exceeding 50kg per person per year, reaching 66 kg per person in parts of Kisii. Productivity of common bean in Kenya is severely constrained by abiotic and biotic stresses, especially diseases such as angular leaf spot, anthracnose, rust, common bacterial blight, bean common mosaic virus (BCMV), Fusarium wilt and root rots. This study was undertaken to evaluate 27 newly identified bean varieties with high iron and zinc concentration for resistance to the major diseases under field conditions. Eight varieties (RWR 10, K 132, MCM 2001, G5686, PVA 8, Soya Fupi, Nguaku Nguaku and Nain De Kyondo) showed high (grade 1 to 3) to moderate (grade 5) levels of resistance to anthracnose, bean rust, common bacterial blight, bean common mosaic virus and root rot. Variety Kiangara had good levels of resistance to all the diseases. These results indicate that some of the newly identified nutrient-rich bean varieties possess good levels of resistance to diseases and their adoption would, therefore, increase bean production and improve human health.
Keywords: Common bean, disease resistance, field evaluation, *Phaseolus vulgaris*

Introduction

The common bean, *Phaseolus vulgaris* L., is a major staple in Eastern and Southern Africa, where it is recognized as the second important source of dietary protein and the third most important source of calories (Wortmann *et al*., 1998). In Kenya, common bean is the most important pulse and is the third most important food crop (GOK, 1998). Bean is characterized as a near perfect food because of its high protein content and generous amounts of iron, folic acid, complex carbohydrates and other diet essentials (Kornegay *et al*., 1996). The crop is particularly suitable for food security because of its nutrient composition, short growing cycle and adaptability to different cropping systems. Beyond its contribution to human nutrition, bean crop has considerable economic importance in providing income for smallholder farmers (Wortmann *et al*., 1998; Mwaniki, 2002). Because the crop is easily grown, is adapted to different cropping systems, tolerates shade in intercropping and has a short growth cycle of only 65-90 days, beans are also important in intensifying agricultural production systems (Wortmann *et al*., 1998).

In Kenya beans are primarily grown by smallholder farmers under adverse conditions such as poor agronomic practices, low input use, marginal lands, intercropping with competitive crops, low soil fertility, periodic water stress, weed competition and damage caused by diseases and insect pests (Nderitu *et al.*, 1997; Mwaniki, 2002; Wagara, 2005). Bean yields have therefore been declining over the years. For example, yields declined from 600 kg ha^{-1} in 1990 to 400 kg ha^{-1} in 2004 (MOARD, 2004). The major bean diseases include angular leaf spot, anthracnose, rust, common bacterial blight, bean common mosaic virus (BCMV), Fusarium wilt and root rots (Wortmann *et al*., 1998). Use of bean varieties with resistance to biotic and abiotic stresses is the most efficient, environmentally friendly and cost effective strategy of reversing the declining productivity.

In the last decade, there has been tremendous efforts in searching for solutions to the production problems facing the bean sub-sector (Kimani *et al*., 2005). High yielding bean varieties with resistance to various biotic and abiotic constraints have been developed. In addition, new bean varieties with high iron and zinc concentration have been identified, with the potential of reversing the widespread micronutrient deficiencies and anaemia (Kimani *et al*., 2001), but their reactions to the major diseases occurring in Kenya has not been determined. This study was, therefore, undertaken to evaluate newly identified nutrient-rich bean varieties for resistance to the major diseases including anthracnose, common bacterial blight, bean common mosaic virus (BCMV), rust and root rots, under field conditions.

Materials and Methods

This study was conducted at Laikipia Campus of Egerton University, located in the Laikipia Escarpment of the Rift Valley. It lies at 0^o 03' South and 36^o 22' East at an altitude of 2490 m.a.s.l. The area has an annual average rainfall of 1022mm and soils are of moderate fertility.

Field evaluation of 27 nutrient-rich bean varieties for resistance to diseases was conducted for two seasons during the long rains of 2005 and 2006. The bean varieties were of different growth habits, seed colour and size (Table 1). Bean seeds were sown 15cm apart in 2 x 4 metre plots in a randomized complete block design. The commonly grown bean variety, Rosecoco GLP-2, was included as a check. General crop management such as weeding and insect pest control was done. Scoring was

done for the major bean diseases that included common bacterial blight, anthracnose, rust, bean common mosaic virus (BCMV) and root rot. Plants were scored for diseases based on a severity scale of 1 to 9 (Van Schoonhoven and Pastor-Corrales, 1987). Plants showing grades 1 to 3 were considered resistant, grade 5 as moderately resistant and those showing grades 7 to 9 as susceptible.

Table 1: Characteristics of bean germplasm evaluated for resistance to diseases

Bean Line	Growth Habit	Seed size	Seed colour
Kirundo	IV	Medium	Yellow
Nakaja	IV	Medium	Yellow
Selian 97	I	Large	Red kidney
MCM 2001	III	Small	Red
RWR 10	I	Large	Red kidney
Red Wolaita	III	Small	Red
PVA 8	I	Large	Red mottled
K 131	II	Small	Cream mottled
MLB 49-89A	III	Medium	Black
Ayenew	III	Medium	Pinto cream
Maasai Red	III	Small	Red
Jesca	I	Large	Purplish
MEX 142	III	Small	White
K 132	I	Large	Red mottled
Soya Fupi	I	Medium	Purplish
Maharagi Soja	IV	Small	Brownish
Kiangara	IV	Medium	Yellow
Mmafutala	II	Small	Red
VCB 81013	IV	Small	White
G 59/1-2	IV	Large	Red kidney
LIB 1	IV	Small	Yellow
Zebra	III	Medium	Cream striped
Lingot Blanc	I	Large	White
Nguaku Nguaku	I	Large	Yellow
Nain De Kyondo	IV	Small	White
Ituri Matata	I	Large	White
GLP-2	I	Large	Red mottled

Results and Discussion

Bean plants were regularly monitored for disease development throughout the growth cycle and scoring for disease severity was done for the most prevalent diseases in the field. The bean varieties developed varying levels of common bacterial blight, anthracnose, bean rust, bean common mosaic virus and root rot (Table 2). During the long rains of 2005 common bacterial blight, anthracnose, rust and BCMV were more prevalent and severe than root rot. Incidence and severity of these diseases increased slightly during the long rains of 2006 with the exception of bean rust, which declined in severity (Table 3). No occurrence of angular leaf spot was reported in the field during the two seasons. Angular leaf spot is reported to be the most damaging and widely distributed disease of common bean, causing yield losses of as high as 80% (Wortmann *et al*. 1998; Stenglein *et al.* 2003). Its absence in the field during the two seasons may be attributed to unfavorable conditions for disease development and low inoculum.

None of the 27 varieties evaluated was susceptible to all the diseases occurring in the field. Each of the bean varieties was resistant or moderately resistant to atleast two of the diseases. Varieties RWR 10, K 132, MCM 2001, G5686, PVA 8, Soya Fupi, Kiangara, Nguaku Nguaku and Nain De Kyondo were resistant (grade 1 to 3) or moderately resistant (grade 5) to all the diseases scored. Variety Kiangara had high to moderate levels of resistance to all the diseases. Varieties Kirundo and VCB 81013 were highly resistant (grade 1 to 3) to anthracnose whereas varieties Ayenew, K132, Soya Fupi, Kiangara, Mmafutala, Nguaku Nguaku, MCM 2001, G5686, PVA 8, Nain De Kyondo and Ituri Matata were moderately resistant (grade 3 to 5) to the disease. Most of the varieties showed moderate levels (grade 5) of resistance to common bacterial blight except K131, which developed grade 7 of disease during the two seasons. Most of the bean varieties showed low levels of bean rust and root rot (grades 3 to 5) during the two seasons. These low disease levels were probably due to low disease pressure and unfavourable conditions. Further evaluations of the varieties for disease resistance will be undertaken at disease hotspots, for example in Kakamega for root rot. In addition, varieties that have shown good levels of disease resistance in the present study will be evaluated under high disease pressure in a screenhouse to ascertain their levels of resistance.

The results of this study indicate that some of the nutrient-rich bean varieties evaluated posses good levels of resistance to the major diseases occurring in farmers' fields and their adoption would, therefore, increase bean production and improve human health. These varieties should be evaluated further for disease resistance in the farmers' fields and those that show good levels of

resistance should be disseminated. Studies have shown that involvement of farmers participatory approaches in variety evaluation enhance adoption and diffusion of new varieties (Odendo *et al*., 2005). This allows farmers to evaluate and select varieties that best suite their farming conditions, local agroecological and socio-ecological niches based on their own criteria.

Table 2: Reaction of nutrient-rich bean lines to common bacterial blight (CBB), bean common mosaic virus (BCMV), anthracnose, rust and root rot during the long rains of 2005

Bean Line	Disease Score				
	CBB	BCMV	Anthracnose	Rust	Root rot
Kirundo	5	7	1	5	1
Nakaja	3	9	5	3	3
Selian 97	5	3	3	3	3
MCM 2001	3	5	3	3	3
G5686	5	3	3	5	3
RWR 10	3	5	3	5	3
Red Wolaita	3	9	3	5	3
PVA 8	5	3	3	3	3
K 131	7	9	5	3	5
MLB 49-89A	5	5	5	3	3
Ayenew	5	5	5	9	3
Maasai Red	5	7	3	5	3
Jesca	1	3	3	5	3
MEX 142	1	7	5	3	3
K 132	3	5	3	3	3
Soya Fupi	3	5	5	5	5
Maharagi Soja	7	5	9	5	3
Kiangara	3	3	3	3	1
Mmafutala	3	7	3	5	3
VCB 81013	1	5	1	3	1
G 59/1-2	5	9	5	7	3
LIB 1	5	7	5	5	3
Zebra	7	5	5	3	3
Lingot Blanc	5	3	3	7	3
Nguaku Nguaku	5	3	3	3	3
Nain De Kyondo	3	5	3	3	3
Ituri Matata	5	3	3	7	5
GLP-2	7	7	9	9	5

Table 3: Reaction of nutrient-rich bean lines to common bacterial blight (CBB), bean common mosaic virus (BCMV), anthracnose, rust and root rot during the long rains of 2006

Bean Line	Disease Score				
	CBB	BCMV	Anthracnose	Rust	Root rot
Kirundo	5	7	3	3	1
Nakaja	5	7	7	5	1
Selian 97	5	3	7	3	3
MCM 2001	3	5	3	3	3
G5686	5	3	3	5	3
RWR 10	5	3	3	3	3
Red Wolaita	5	5	7	5	3
PVA 8	5	3	3	3	3
K 131	7	3	7	3	5
MLB 49-89A	5	5	9	3	3
Ayenew	7	7	5	5	3
Maasai Red	5	9	7	3	3
Jesca	5	3	7	3	3
MEX 142	5	9	7	3	5
K 132	5	3	5	3	3
Soya Fupi	5	5	3	5	5
Maharagi Soja	5	7	7	5	3
Kiangara	5	5	5	3	1
Mmafutala	5	7	5	3	3
VCB 81013	5	7	3	5	1
G59/1-2	7	9	7	5	3
LIB 1	3	9	7	3	3
Zebra	5	5	7	3	3
Lingot Blanc	7	5	7	5	3
Nguaku Nguaku	5	3	5	3	3
Nain De Kyondo	3	5	3	3	3
Ituri Matata	5	3	5	5	5
GLP 2	7	7	9	9	5

Some of the nutrient-rich bean varieties reported in this study to possess good levels of resistance to various diseases are of the seed-types preferred by farmers and consumers. For example, varieties K 132 and PVA 8 are red mottled large-seeded types whereas RWR 10 is a large-seeded red kidney variety (Table 1). It has been reported that large-seeded red or red-mottled bean varieties like Rosecoco GLP-2 are among the most popular with farmers and consumers in Kenya because of their seed size and color (Korir *et al*., 2005). Unfortunately, bean variety Kiangara, which showed resistance to all the diseases, is a medium-sized yellow variety that may not be popular with farmers and consumers. Such varieties can, however, be used as sources of resistance to improve the preferred, but susceptible, bean varieties.

Acknowledgement

Financial support for this work was provided by East and Central Africa Bean Research Network (ECABREN) whom we gratefully acknowledge.

References

GOK. 1998. Government of Kenya Economic Survey 1997. Central Bureau of Statistics, Nairobi, Kenya.

Kimani, P.M., Karuri, E. & Mwaura, S. 2001. Variation in iron and zinc in African bean landraces. CIAT Annual Report, CALI, Colombia.

Kimani, P.M., Buruchara, R.A., Ampofo, K., Pyndji, M., Chirwa, R. & Kirkby, R. 2005. Breeding bean for smallholder farmers in Eastern, Central and Southern Africa: Constraints, Achievements and Potential. CIAT, Cali, Colombia. (In Press).

Korir, M.K., Odhiambo, M.O., Iruri, D.M., Kipsat, M.J. & Serem, A.K. 2005. Bean Varietal preference in East African markets and its implications to breeding. African Crop Science Conference proceedings, **7**, 803-805.

Kornegay, J., Nathan, R., Martinez, G.J.C. & Impresion, F.S.A. 1996. The African Bean Exchange: Patterns of sharing. Cali, Colombia: Centrol Internacional de Agricultura Tropical. 12pp.

Ministry of Agriculture and Rural Development (MOARD). 2004. Annual Report. Nairobi, Kenya.

Mwaniki, A.W. 2002. Assessment of bean production constraints and seed quality and health of improved common bean seed. MSc Thesis, University of Nairobi, 113 pp.

Nderitu, J.H., Buruchara, R.A. & Ampofo, J.K. 1997. Relationships between Bean Stem Maggot, Bean root rots and soil fertitlity. African Highland Initiative, Nairobi. 16pp.

Odendo, M., Otsyula, R., Kalyebara, R., Buruchara, R. & David, S. 2005. The key role of beans in alleviating poverty and providing food security: Effect of improved bean varieties in western Kenya. A paper presented at the 2nd Biotechnology, Breeding and Seed Systems for African Crops conference held in Nairobi, Kenya, 24th-27th January, 2005.

Stenglein, S., Ploper, L.D., Vizgarra, O. & Balatti, P. 2003. Angular leaf spot: A disease caused by the fungus *Phaeoisariopsis griseola* (Sacc.) Ferraris on *Phaseolus vulgaris* L. Advances in Applied Microbiology, **52**, 209-243.

Van Schoonhoven, A. & Pastor-Corrales, M.A. 1987. Standard system for the evaluation of bean germplasm. C.I.A.T., Cali, Colombia. 49 pp.

Wagara, I.N. 2005. Molecular and virulence characterization of *Phaeoisariopsis griseola* and reaction of bean germplasm to races of the angular leaf spot pathogen. Ph.D. Thesis, University of Nairobi. 166 pp.

Wortmann, C.S., Kirkby, R.A., Elude, C.A. & Allen, D.J. 1998. Atlas of common bean (*Phaseolus vulgaris* L.) production in Africa. CIAT publication No.297. 133pp.