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Research Application Summary

Quality of wheat seed used by farmers in Nakuru County

Buyela, S.N.[1], Muthomi, J.W.[1], Mwang'ombe, A.W.[1], Njau, P.N.[2] & Olubayo, F.M.[1]

[1]Department of Plant Science and Crop protection, University of Nairobi, P.O. Box 30197-00100, Nairobi, Kenya
[2] Highlands Agriconsults Services, P. O. Box 536, Njoro, Kenya
Corresponding author: sharonbuyela@yahoo.com

Abstract

Production of wheat in Kenya has been below its potential and this has been attributed to recycling of seed, among other factors. Recycled seed may harbour seed borne pathogens which may accumulate over time resulting in increased disease incidences which lead to poor germination, poor emergence, and hence poor crop stand and ultimately low yield. This study sought to determine the quality of wheat seed used by farmers in Nakuru County. A total of 66 samples were collected from farmers in the major wheat growing areas. The samples were subjected to purity test to determine the weight of pure seed, insect damaged seed, discoloured seed, shrivelled seed, other crop seed, weed seed and inert matter. Germination test was also done to determine the number of germinated seeds, mouldy seeds, hard seeds, normal seedlings, abnormal seedlings and seedlings with infection. All the seed samples did not meet the minimum purity and germination standards of 99% and 85%, respectively. There was significant variation in the percentage of pure seeds from the different agro-ecological zones. The highest percentage physical purity of 92% was recorded in Agro-ecological zone UH2. The main contaminant of physical purity was inert matter. Significant variation was also observed in germination of the seeds and percentage of normal, abnormal and infected seedlings from the different regions. Agro-ecological zone UH2 recorded the highest percentage of normal seedlings of 83%. Agro-ecological zone LH3 recorded the highest levels of abnormal and infected seedlings. Therefore, recycling of seed reduces seed quality which in turn lowers productivity. Farmers should be advised on the importance of using certified seed or practicing quality seed management practices in order to prevent seed damage and improve production.

Key words: Seed germination, Nakuru, physical purity, seed quality, *Triticum aestivum*

Résumé

La production de blé au Kenya a été inférieure à son potentiel et cela a été attribué au recyclage des semences, entre autres facteurs. Les semences recyclées peuvent héberger des agents pathogènes transmis par les semences qui peuvent s'accumuler au fil du temps, ce qui entraîne une augmentation de l'incidence des maladies, ce qui entraîne une mauvaise germination, une mauvaise émergence et, par conséquent, un peuplement médiocre et finalement un faible rendement. Cette étude visait à déterminer la qualité des semences de blé utilisées par les agriculteurs du comté de Nakuru. Au total, 66 échantillons ont été collectés auprès des agriculteurs des principales zones de culture du blé. Les échantillons ont été soumis à un test de pureté pour déterminer le poids des graines pures, des graines endommagées par les insectes, des graines décolorées, des graines ratatinées, des autres graines de culture, des graines de mauvaises herbes et de la matière inerte. Un test de germination a également été effectué pour déterminer le nombre de graines germées, de graines moisies, de graines dures, de semis normaux, de semis anormaux et de plants infectés. Tous les échantillons de semences ne répondaient pas aux normes minimales de pureté et de germination de 99% et 85%, respectivement. Il y avait une variation significative du pourcentage de semences pures des différentes zones agro-écologiques. Le pourcentage de pureté physique le plus élevé de 92% a été enregistré dans la zone agro-écologique UH2. Le principal contaminant de la pureté physique était la matière inerte. Une variation significative a également été observée dans la germination des graines et le pourcentage de plants normaux, anormaux et infectés des différentes régions. La zone agro-écologique UH2 a enregistré le pourcentage le plus élevé de plants normaux de 83%. La zone agro-écologique LH3 a enregistré les niveaux les plus élevés de semis anormaux et infectés. Par conséquent, le recyclage des semences réduit la qualité des semences, ce qui à son tour réduit la productivité. Les agriculteurs doivent être informés de l'importance d'utiliser des semences certifiées ou de pratiquer des pratiques de gestion des semences de qualité afin de prévenir les dommages aux semences et d'améliorer la production.

Mots clés : germination des graines, Nakuru, pureté physique, qualité des graines, *Triticum aestivum*

Introduction

Seed is the basic and the most critical input in agricultural production. Seed quality determines agricultural productivity in terms of both quantity and quality. Quality of seed influences germination, seedling emergence, crop stand and yield (Kamara *et al*., 2014). Quality seed ensures genetic and physical purity of the crop and produces vigorous seedlings that can tolerate pests and diseases and ensure uniform growth of the crop to maturity (Osikinyi, 2010).

Wheat production in Kenya has been low contrary to high and increasing demand. Most wheat farmers especially the small scale farmers use recycled seed whose quality is largely unknown (MOA, 2013; Beye and Wopereis, 2014). Seed quality deteriorates during storage and the intensity of deterioration depends on the initial quality of the seed before storage such as moisture content, storage condition and storage duration. Recycled seed could harbour seed borne pathogens which can lead to outbreak and spread of diseases that increase incidences of seed rots, seedling infections and abnormalities, and pre and post emergence mortality thereby resulting in poor crop establishment and eventually reduction in yield. This study was carried out to determine the quality of seeds used by farmers in Nakuru County in Kenya.

Materials and methods

Description of the study area. The study was carried out in the major wheat growing agro-ecological zones of Nakuru County. The study areas included Upper highland zone two (UH2), Upper highland zone three (UH3) and Lower highland zone three (LH3) of Njoro, Bahati and Rongai sub-counties, respectively. Agro-ecological zone LH3 lies between altitude 1890-2190m above sea level and receives an annual rainfall of 890-1100mm and an annual temperature of 17.5-15.7°C. Agro-ecological zone UH2 lies between altitude 2400-2800m above sea level, with an annual rainfall of 1100-1400mm and annual temperature of 15.0-11.2°C while AEZ UH3 lies between 2400-2580m above sea level and receives an annual rainfall of 890-950mm and annual temperature of 15.0-13.9°C. The lengths of growing periods varies, 225-230 days for LH3, 270-300 days for UH2 and 260-270 days for UH3 (Jaetzold *et al*., 2006; Okumu, 2014).

Collection of seed samples, and seed germination and purity test. Wheat seed samples were collected from farmers in Nakuru County during the 2015 growing season. The farmers were from the three major wheat growing agro-ecological zones of the County which included Upper highland zone two (UH2), Upper highland zone three (UH3) and Lower highland zone three (LH3) of Njoro, Bahati and Rongai sub-counties respectively. Both large and small scale farmers were systematically sampled by selecting every third wheat farmer in a transect line along the road. A total of 66 seed samples of 250 grams each were collected.

Purity and germination tests were carried out twice between March and May 2016 at the University of Nairobi, Faculty of Agriculture. Germination test was carried out by placing four replicates of 100 seeds each between wet paper towels. The experiment was set up at room temperature for germination test in a completely randomized design.

To determine seed purity, three replicates of 100 grams each were drawn from each sample, placed on a manila paper and separated into pure seed, discoloured seeds, shrivelled seeds, insect damaged seeds, other crop seeds, other varieties, weed seeds and inert matter. Each of the components was then weighed and the weight of each fraction recorded. Percentage purity was calculated using the following formulae:

$$\text{Component (\%)} = \frac{\text{Weight of each component fraction}}{\text{Total test sample weight (100 g)}} \times 100$$

Germination was determined by counting the number of germinated seeds, mouldy seeds, hard seeds, normal seedlings, abnormal seedlings and infected seedlings at an interval of two days for ten days after germination (Khan *et al*., 2015; Faligowska *et al*., 2016). Mouldy seed was any seed that had fungal mycelium on its surface while a hard seed was ungerminated seed that had no infection but remained hard at the end of the experiment (Patil *et al*., 2008). A seedling was considered normal if all its morphological structures were well developed and healthy or had slight defects or secondary infections while an abnormal seedling was a seedling that did not show the potential to develop into a normal plant when grown, for instance, damaged, deformed or decayed seedlings (Ehiagbonare *et al*., 2008). A seedling with infection was either normal or abnormal and was considered abnormal if it was decayed as a result of primary infection so that normal development was prevented and the infection was determined by visual examination of the seedlings to identify disease symptoms such as discoloration. Germination percentage was calculated as follows;

$$\text{Percentage germination} = \frac{\text{Germinated seeds}}{\text{Total seeds}} \times 100$$

All the data collected were subjected to analysis of variance (ANOVA) using GENSTAT version 12.0 and means separated using Fishers protected at 5% significance level (Steel *et al*., 1997).

Results

Percentage purity of all the seed samples did not meet the minimum purity standard of 99% as recommended by ISTA (Table 1). There was significance difference in the percentage of pure seeds from the different agro-ecological zones. Agro-ecological zone UH2 had the highest percentage of pure seeds while the least was recorded in agro-ecological zone LH3. The main source of contamination was inert matter followed by shrivelled and discoloured seeds while the least contaminant was seeds from other crops. The percentage of shrivelled seeds was significantly different among the agro-ecological zones with the highest being recorded in agro-ecological zone LH3.

All the seed samples recorded germination percentages of less than 85%, the minimum accepted standard germination (Table 2). Significant variation was noted in the percentage of normal seedlings from the different agro-ecological zones with the highest being recorded in agro-ecological UH2 while the least was from LH3. There was also significant variation in the percentage of abnormal as well as infected seedlings. The highest seedling abnormality and infection were recorded in agro-ecological zone LH3.

Discussion

Physical purity of the seed samples were below the recommended standard and varied. Inert matter was the main source of contamination followed by shrivelled and discoloured seeds. Germination percentage was also below the minimum standard and different among the samples. Seedling infection levels of the samples were also different. Similar studies by Bishaw *et al*. (2012) also showed that physical purity of wheat seed samples from farmers in Ethiopia and Syria were below 99% while Oshone *et al*. (2014) reported that there was variation in proportion of pure seed from seed samples obtained from small scale farmers in Ethiopia. Oshone *et al*. (2014) and Kadaari (2015) also found that common beans in Ethiopia and Kenya respectively did not meet the recommended germination standards.

Table 1. Percentage seed purity parameters of wheat from different agro-ecological zones in Nakuru County, Kenya

AEZ (N=66)	Pure seeds	Insect damaged seeds	Discoloured seeds	Shrivelled seeds	Other crop seeds	Weed seeds	Inert matter
LH3	91.55b	0.39a	1.63a	2.15a	0.02a	0.08a	4.17a
UH2	92.48a	0.02b	1.48a	1.75b	0.02a	0.03b	4.21a
UH3	91.78ab	0.04b	1.65a	2.09ab	0.03a	0.05ab	4.38a
Mean	91.94	0.15	1.59	2.00	0.02	0.05	4.25
LSD ($P<0.05$)	0.83	0.14	0.33	0.37	0.02	0.03	0.65
CV(%)	2.60	26.34	60.70	54.10	21.98	190.60	44.20

N = Sample size, AEZ = agro-ecological zone, LH3 = lower highland zone 3, UH 2 = upper highland zone 2, UH3 = upper highland zone 3, LSD = least significant difference and CV = coefficient of variation

Table 2. Percentage viability and infection of wheat seed from different agro-ecological zones in Nakuru County

AEZ (N=66)	Viability				Infection	
	Germinated seeds	Normal seedlings	Abnormal seedlings	Hard seeds	Mouldy seeds	Infected seedling
LH3	97.8a	81.4b	16.4a	0.2a	2.0a	22.1a
UH2	96.9b	83.5a	14.2b	0.3a	1.9a	19.1b
UH3	97.0b	82.8ab	15.1ab	0.2a	1.9a	18.9b
Mean	97.2	82.6	15.2	0.2	1.9	20.0
LSD (P<0.05)	0.6	1.7	1.8	0.2	0.6	1.8
CV(%)	2.0	7.1	39.3	23.3	95.2	31.0

N = Sample size, AEZ = agro-ecological zone, LH3 = lower highland zone 3, UH2 = upper highland zone 2, UH3 = upper highland zone 3, LSD = least significant difference and CV = coefficient of variation

The variation in pure seed and failure to meet the minimum purity standards could be due to poor agronomic practices such as contamination by weeds (Bishaw *et al*., 2012). Poor pre and post-harvest handling practices such as seed cleaning and storage also affect the physical quality of seed (Surki *et al*., 2012; Ochichi, 2015). Variation in shrivelled seeds could be attributed to prevalence of wheat diseases in some agro-ecological zone as compared to in others probably due to favourable weather condition for disease development in a specific agro-ecological zone (Osborn *et al*., 2010; Ochichi, 2015). Seed discolouration or shrivelling is an indication of disease caused by the presence of seed borne pathogen inoculums present in the seed (Asfaw *et al*., 2013; Boersma *et al*., 2015). Failure to meet the recommended germination standard could be attributed to seed deterioration during storage as a result of packaging material, and poor storage conditions which encouraged disease infestation or ageing effect that led to depletion of food reserves within the seeds (Pradhan and Badola, 2012; Sibande *et al*., 2015). Increase in storage period contributes to accumulation of fungal pathogens that reduce germination capacity (Shaban; 2013; Kishore *et al*., 2014; Caldeira *et al*., 2015). Variation in the percentage of normal seedlings could also be due to genetic factors, agronomical and ecological conditions as well as unhygienic storage practices by different farmers in the different agro-ecological zones which enhance seed borne mycoflora (Chirchir *et al*., 2016). Variation in seedling infection levels may also be due to differences in environmental conditions among the three agro-ecological zones (Wagacha *et al*., 2016). For instance, the incidence and severity of *Fusarium* head blight during cropping season is influenced by weather conditions whereby, warm dry soil conditions during early times of the cropping season enhance the development of *Fusarium* root rot and production of inoculum on plant bases (Okumu, 2014).

Conclusion

All the seed samples did not meet the minimum purity and germination standards for wheat seed as recommended by ISTA. As such, farmers need to be guided on how to enhance seed quality.

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